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AUTOMATED HALL EFFECT EXPERIMENT DATA ACQUISITION SYSTEM (AHEED--ETC(U)

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AUTOMATED HALL EFFECT EXPERIMENT DATA ACQUISITION SYSTEM (AHEEDAS)

THESIS

AFIT/GEO/EE/79D-5 Edgar A. Verchot, Jr.
Captain USAF

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AFIT/GEO/EE/79-5

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AUTOMATED HALL EFFECT EXPERIMENT DATA ACQUISITION SYSTEM (AHEEDAS).

9 Master's THESIS

Presented to the Faculty of the School of Engineering
of the Air Force Institute of Technology
in Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Electrical Engineering

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10 Edgar A. Verchot, Jr., B.S., B.S.E.E.
Captain USAF
Graduate Electro Optics

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Preface

Dr. Patrick M. Heminger of the Air Force Materials Laboratory, Wright-Patterson Air Force Base, Ohio, developed and built a Hall effect experimental apparatus to gather data on the impurity levels and electrical properties of silicon samples. While successful, the experiment was long and awkward to perform. He decided to automate it and towards this end purchased an LSI-11 microcomputer system and automated instrumentation compatible with it. Starting with the system, I designed and implemented the software system necessary to make this system function. This report details the process of designing and implementing this system.

I want to thank Dr. Thomas C. Hartrum, my thesis advisor, for his help and guidance. He provided the basic direction from which I was able to proceed to begin the design of AHEEDAS, and as the design progressed, was always available to discuss problem areas. In addition, he went over multiple drafts of this report in detail to help shape it into a useable product. The other members of the committee, Dr. Gary B. Lamont and Capt. John M. Borky also provided valuable guidance during the course of this project.

I also want to thank Dr. Hemenger, the thesis sponsor who provided the thesis topic and Mr. Steve Smith of the University of Dayton Research Institute (on site contractor). Both of these men provided valuable guidance on the desired results of the experiment and suggestions as to how the

calculations necessary to implement the various functions might best be done.

Special mention must go to Mr. Frank E. Beital and Mr. Dane Hanby of the University of Dayton Research Institute (on site contractors). Mr. Beital wrote several of the device drivers and provided continual and invaluable guidance on how the LSI-11 could be made to efficiently perform the desired functions. Whenever I reached a "dead end," he was usually able to show me the error(s) that I had made and put me back "on track." Mr. Hanby did all of the hardware interfacing for the automated equipment. He designed and built several of the interfaces from "scratch" and without his expertise, the AHEEDAS would have had no system to control.

I would also like to thank Capt. William Walker for allowing me the use of the resources of the Computer Activities Division, Air Force Materials Laboratory, without which successful completion of this thesis would not have been possible and to Ms. Carla Smith who typed the final copy of this report.

Finally and most importantly, I would like to thank my wife, Deborah, and son, Edgar. Without their love, understanding and support through the long nights and weekends, this thesis would not ever have been finished.

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Abstract

The Air Force Materials Laboratory conducts experiments using the Hall effect to characterize the electrical properties and impurity levels of silicon samples. Both the van der Pauw and the classical Hall bar methods are used.

The purpose of this study was the development of an Automated Hall Effect Experiment Data Acquisition System (AHEEDAS) to control the conduct of the experiment and to reduce all of the necessary data. The design system is capable of controlling all aspects of the experiment except the temperature. The AHEEDAS produces as output, sample resistivity, Hall mobility, carrier concentration and the Hall coefficient as a function of temperature. These are stored in data files on floppy disk storage along with all of the raw data from the experiment. The output is also printed on the computer terminal as the experiment is done.

An LSI-11 microcomputer with 28K words of memory is used to control the experiment. Software was developed to allow this system to handle the acquisition and processing of data. The AHEEDAS was successfully implemented and tested. All functions other than the temperature control are fully operational.

I. Introduction

The Air Force Materials Laboratory (AFML), Wright-Patterson Air Force Base, Ohio, uses a Hall effect experiment to analyze the dopant and impurity content of silicon samples. They wanted to develop an Automated Hall Effect Experimental Data Acquisition System (AHEEDAS) in order to increase both the speed and accuracy of their experiment. This report describes the design, development and implementation of this system.

Background

The concentrations and activation energies of electrically active impurities are important quantities for the complete characterization of semiconductors. Measurements of sample resistivity and Hall voltage versus temperature enable the experimenter to determine the electrical transport properties of a semiconductor sample from which the net impurity concentrations and carrier mobility can be determined (Ref 4).

The experiment was originally done manually; it took from six to eight hours to make all the necessary measurements on one sample. Using the van der Pauw method, twenty voltage versus current measurements are made for each temperature point. Thirty to sixty temperature points are needed for a complete curve. Therefore, 600 to 1200 data points are needed for each sample. Clearly automation was needed to assist in this experiment. In addition to freeing the experimenter to do other tasks, the experiment could be

greatly enhanced by the increase in accuracy as well as speed. The increased speed allows many more data points to be taken per sample.

Statement of Problem

The purpose of this study was to design and implement the hardware and software to control the Hall Effect experiment and to collect and reduce the data from it with an LSI-11 data acquisition system. The system was to be designed to control all aspects of the experiment and to take all required data. These data were to be written onto floppy disc storage for later use. A real-time monitoring of the experimental data was required. Future expansion needs were also to be defined.

Constraints/Assumptions

Prior to requesting assistance with developing the system, AFML purchased an LSI-11 microcomputer system (described in Chapter II) and automated instrumentation. This constrained the freedom of hardware selected. The only hardware which was not specified was that for the implementation of the temperature controller and that future expansion.

The user requested that for the first stage of development the temperature control be left manual and that the remainder of the system be implemented. This was to ensure that a minimum system would be made operational by the end of this investigation.

Scope of Thesis

The structured analysis and design technique (SADT) (Ref 11) was used to develop the activity model of AHEEDAS (Ref Chapter III). The LSI-11 microprocessor was used as the processor. It and its associated hardware system are discussed along with the experimental environment in Chapter II. The software modules were designed and coded (Chapter IV). The hardware and the software were integrated and functionally tested (Chapter V). All portions of the first stage system are functional at this time. Recommendations for further study have been included in Chapter VI.

II. Experimental Environment

Before the requirements of the system are defined, the original environment, including the design constraints, will be described and discussed. Once all of the constraints are identified, the next step of the analysis can be performed. In this chapter, the background theory of the Hall Effect experiment will be discussed, followed by a discussion of the originally purchased hardware system.

Theory

Two types of sample configurations are used in the Hall Effect experiment: the van der Pauw and the Hall bar (Ref 22). The geometry of the two configurations and the calculations necessary to use them are presented below.

The van der Pauw technique uses a sample having only four electrical contacts (see Figure 1). In each of the six configurations shown, the potential difference between V1 and V2 is recorded. Additionally, these measurements are repeated with the battery polarity reversed. In sample configurations (e) and (f), the voltage difference between V1 and V2 with a magnetic field applied perpendicularly to the sample is also measured. Both polarities of the field must be used for these measurements (Ref 4). From these data, four parameters are calculated: resistivity, Hall mobility, carrier concentration, and the Hall coefficient.

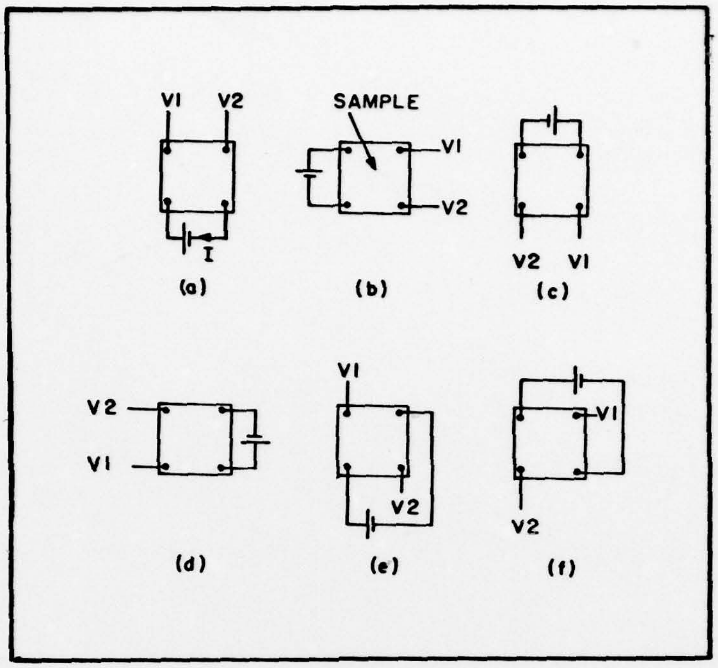

Figure 1. van der Pauw Configuration Sample Geometry.

The derivations of the necessary formulae for both the van der Pauw and the Hall bar configurations can be found in the van der Pauw report on the Hall Effect experiment (Ref 22).

Resistivity, ρ, in ohms-centimeters, is given by,

$$\rho = \frac{\pi t(R_a + R_b)}{2\ln 2} f\left(\frac{R_a}{R_b}\right) \tag{1}$$

where t is the thickness of the sample in centimeters, and R_a is found, using sample configuration (a) from

$$R_a = \frac{V_a}{I_a} \quad (2)$$

where V_a is the voltage difference between V1 and V2, and I_a is the current between the battery contacts. Likewise from sample configuration (b)

$$R_b = \frac{V_b}{I_b} \quad (3)$$

Sample configuration (c) is equivalent to (a), and (d) is equivalent to (b). Both polarities of these configurations are measured and the results averaged. The parameter $f\left(\frac{R_a}{R_b}\right)$ is the "van der Pauw f," which is approximated by Reference 22.

$$f = 1 - \left(\frac{R_a - R_b}{R_a + R_b}\right)^2 \left(\frac{\ln 2}{2}\right) - \left(\frac{R_a - R_b}{R_a + R_b}\right)^4 \left[\left(\frac{\ln 2}{4}\right)^2 - \left(\frac{\ln 2}{12}\right)^3\right] \quad (4)$$

Hall mobility, μ_h, in square centimeters/volt-second is given by

$$\mu_h = \frac{\Delta R_e t}{\rho B} \cdot 10^8 \quad (5)$$

where t is sample thickness, ρ is resistivity, B is the applied magnetic field in gauss, and ΔR_e is the change in resistance computed from position (e) of Figure 1 when the magnetic field is applied perpendicularly to the sample.

The value of ΔR_e can be found by analyzing the three possible cases (See Figure 2.).

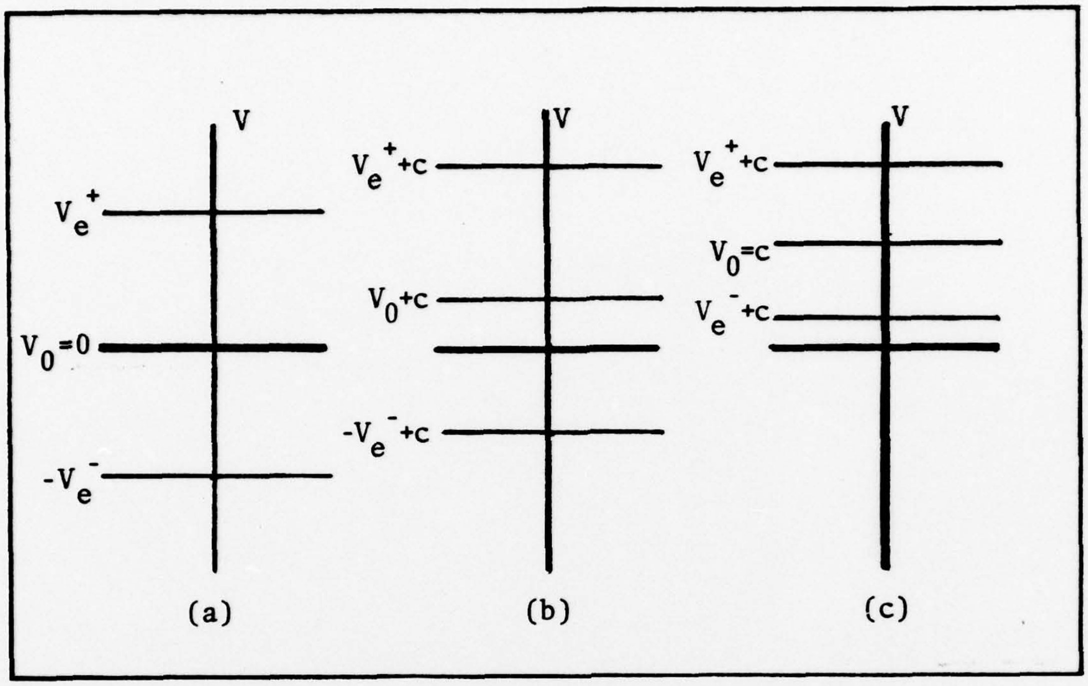

Figure 2. The Three Possible Cases for V_e.

V_e^+ is the voltage measured in sample position (e) with an applied magnetic field; V_e^- is the same measurement with the magnetic field reversed, and V_o is an offset voltage generated by non-uniform sample composition or geometry or both. Reversal of the current polarity and proper averaging of the measured voltages give a correct value for the true Hall voltage, V_e. Now,

$$R_e^+ = \frac{V_e^+ + c}{I_e^+} \tag{6}$$

and

$$R_e^- = \frac{V_e^- + c}{I_e^-} \tag{7}$$

therefore,

$$\Delta R_e = \frac{|R_e^+ - R_e^-|}{2} \tag{8}$$

or

$$\Delta R_e = \frac{\left|\frac{V_e^+}{I_e^+} - \frac{V_e^-}{I_e^-}\right|}{2} \tag{9}$$

where V_e^+ and V_e^- are as defined above and I_e^+ and I_e^- are the corresponding currents. The above measurements are repeated with the current reversed and the results are averaged. Position (f) yields the same results and these are averaged with the results from (e).

Carrier concentration, p, in inverse centimeters cubed, can be determined from

$$p = \frac{1}{\mu_c e \rho} \doteq \frac{1}{\mu_h e \rho} \tag{10}$$

where μ_c is the conductivity mobility, μ_h is the Hall mobility, e is the electronic charge in coulombs and ρ is the resistivity in ohms-centimeters. Conductivity mobility is approximated by the Hall mobility because precise information about $\frac{\mu_c}{\mu_h}$ is not available. It can be assumed that

$$\frac{\mu_c}{\mu_h} \doteq 1 \tag{11}$$

The Hall coefficient, R_H, in centimeters cubed coulomb,

is given by

$$R_H = \frac{1}{pe} = \mu_c \rho = \mu_h \rho \tag{12}$$

where ρ is the resistivity in ohm-centimeters, μ_c is the conductivity mobility in squared centimeters/volt-second, p is the carrier concentration in inverse centimeters cubed, e is the electronic charge in coulombs, μ_h is the Hall mobility in squared centimeters/volt-second.

The Hall bar geometry is shown in Figure 3.

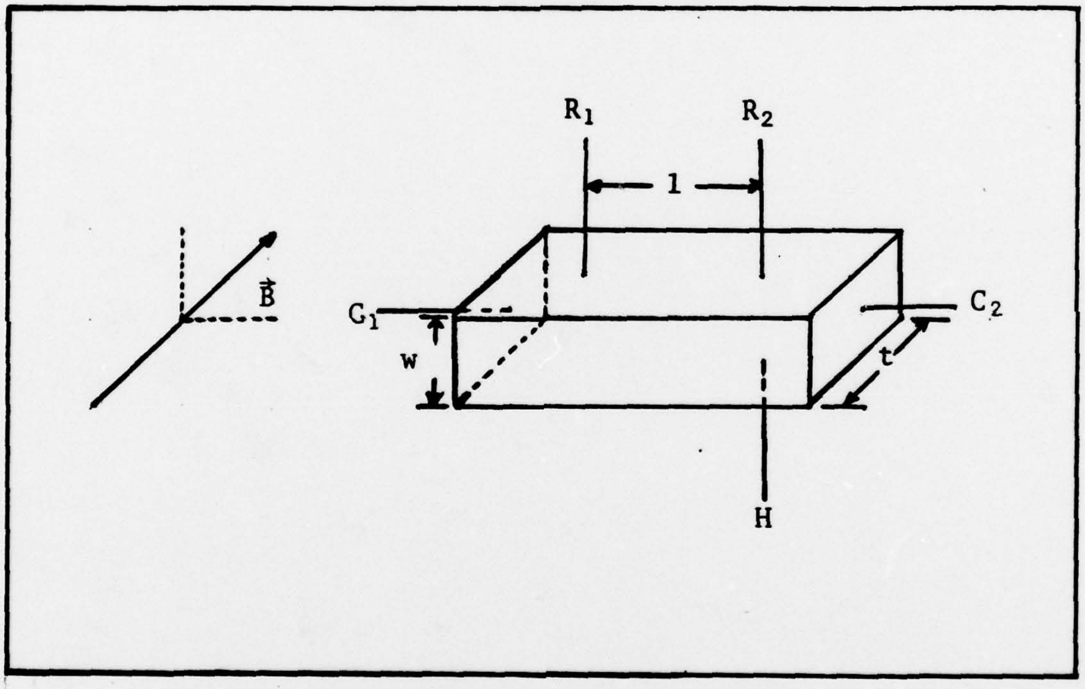

Figure 3. Hall Bar Configuration Sample Geometry.

As Figure 3 shows, the Hall bar sample has five contacts rather than the four of the van der Pauw. The equations used for this configuration are similar to those used for the van der Pauw sample. However, with this sample all three dimensions must be known instead of just the

thickness of the sample. The method is discussed completely in the Reference 22. The formulae needed to reduce the sample data for the Hall bar are given below.

Resistivity, ρ, in ohm centimeters, is given by

$$\rho = \frac{wtV}{lI} \tag{13}$$

where w is the sample width in centimeters, t is the thickness in centimeters, l is the distance in centimeters between contacts R1 and R2 in Figure 3, V is the voltage drop between the contacts and I is the current between contacts C1 and C2, in amperes.

Hall mobility, μ, in centimeters squared/volt-second, is given by

$$\mu_h = \frac{1}{wB} \left(\frac{I}{I'}\right)\left(\frac{V_H}{V}\right)\left(10^8\right) \tag{14}$$

where B is the magnetic field, in gauss, V_H is the voltage measured between R2 and H with the magnetic field applied, I' is the corresponding current.

Carrier concentration, p, in inverse centimeters cubed is given by

$$p = \frac{B}{et}\left(\frac{I'}{V_H}\right) \tag{15}$$

where B, I', V_H, and t are defined above, and e is the electronic charge in coulombs.

The Hall coefficient, R_H, is as defined in equation (12). These are the formulae that are used in the experiment to produce the output data.

System Hardware

Figure 4 shows the block diagram for the hardware system which had been purchased. The components are as follows.

--- Digital Equipment Corporation (DEC) LSI-11 micro-computer with 4K words of memory.

--- DEC RXV 11 dual floppy disk option with dual RX01 floppy disk drive.

--- 24K words of add-on memory.

--- Anderson Jacobson A242A acoustic coupler and DLV-11 serial interface card.

--- Hewlett-Packard Model 7221A, Remote terminal Four Color X-Y plotter (not yet received) with DLV-11 serial interface card.

--- Computer Devices Terminal Model Miniterm 1202, with DLV-11 serial interface card.

--- Hewlett-Packard Digital Voltage Source, Model 6130C, with two DRV-11 parallel interface cards.

--- Walker Magnemetrics Gaussmeter, Model MG-3D with DRV-11 parallel interface card.

--- Magnet controller (designed and built in-house by University of Dayton Research Institute contractor) with DRV-11 parallel interface card.

--- Test Controller (designed and built by University of Dayton Research Institute contractor) with DRV-11 parallel interface card.

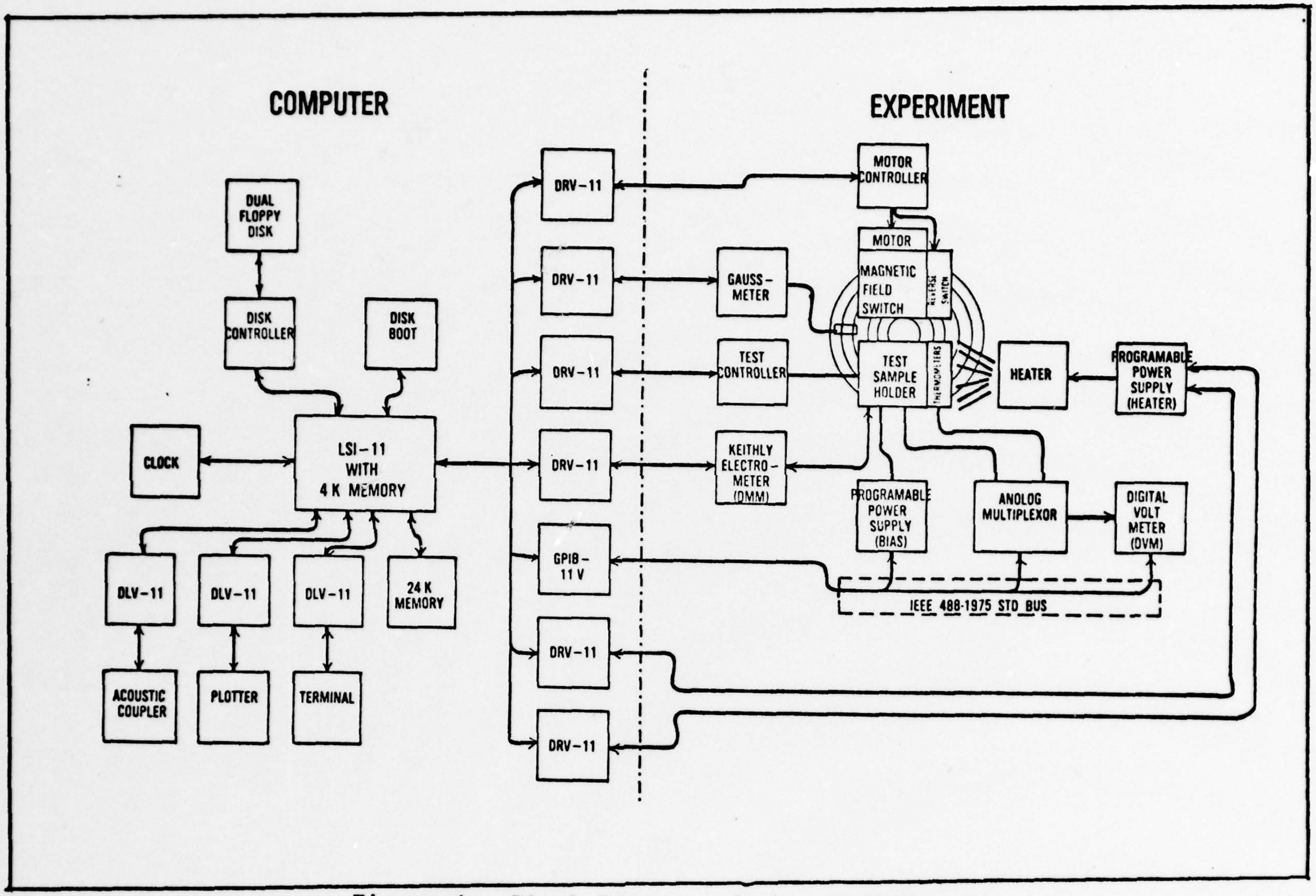

Figure 4. Block Diagram of the AHEEDAS

--- Hewlett-Packard, IEEE 488-1975 compatible, HPIB isolated Digital/Analog/Power Supply programmer, Model 59501A.

--- Keithley Digital Electrometer, Model 616 with Model 6162 isolated output control with DRV-11 parallel interface card.

--- Hewlett-Packard, IEEE 488-1975 compatible, Digital Voltmeter, Model 3455A.

--- Hewlett-Packard, IEEE 488-1975 compatible, Multiplex Scanner, Model 3485A.

--- Hewlett-Packard, IEEE 488-1975 compatible, GPIB-11 instrumentation bus controller.

Each piece of equipment was interfaced to the LSI-11 with a small MACRO assembly language driver subprogram supplied by AFML/DOC (reference Appendix C). All but two pieces of the equipment were adequate for the implementation of the system. It was not determined whether the Hewlett-Packard Model 6130C, Digital Voltage Source would be adequate for the temperature control. See the Recommendations in Chapter VI for more discussion of this problem. The Walker gaussmeter is a problem. It intermittantly locks up in use. The digital interface appears to have been added by the manufacturer as an afterthought to the design and is very awkward to use. At best, its use will be limited by the lack of any auto ranging ability. The system was designed to work automatically with or without the gaussmeter in the circuit. The GPIB-11 controller and software were a continuous source of

problems. However, these problems were solved after much consultation with National Instruments. They ultimately replaced both the original interface card and the software. Future expansion of the system may uncover more problems with this interface.

Original Environment

Originally, the experiment was executed manually. The temperature was controlled with an analog, closed-loop controller. All other instrumentation was manually operated. The operator had to set the voltage across the sample, switch between sample positions, and set the field as well as set the temperature controller. Data were read by the operator and hand logged. An abbreviated set of data points was used for van der Pauw samples in order to keep the execution time of the experiment down to about six hours. On the first and each succeeding alternate temperature, sample configurations, plus and minus a, plus and minus b, and plus and minus e were done (reference Figure 1). On the second and each succeeding alternate temperature, sample configurations plus and minus c, plus and minus d, and plus and minus f were executed. In this manner, 20 to 30 temperature points could be taken in the range from about 20 degrees Kelvin to 300 degress Kelvin. These data were then entered manually into a computer so that they could be reduced and analyzed. Hall bar samples were run in a similar manner except that it was not necessary to abbreviate the set of data points used.

Summary

In this chapter, the pre-existing system constraints were briefly listed and discussed. The original manual method of executing the experiment was also discussed to give some background on what will be required of AHEEDAS. In the next chapter, the requirement for AHEEDAS will be defined using SADT.

III. Requirements Definition

It is difficult to translate the conceptual idea for any system larger than trivial size, into the solid basis for system design. The first step of the design was to break the complete system into functional subunits, or modules. The modules are further divided until their function is simple enough to be easily defined. This process is called the requirements definition phase. A carefully done requirements definition ensures that the system requirements are fully understood by both the system designer and the system user. Ambiguities in the design and implementation are eliminated.

Method for Analysis and Design

The Structured Analysis and Design Technique (SADT) is a design methodology for performing the functional analysis and design of complex systems (Ref 11). A functional model (usually referred to as an activity model) is created first to aid in understanding what activities the system is expected to perform. This activity model is then validated with the system user to ensure that all requirements have been met. Any necessary changes are easily and quickly made at this stage. Following validation, the functional model is broken down further to create the actual design model which will show how the system actually performs its functions. The SADT methodology is defined in Appendix A.

The SADT was chosen as the analysis and design tool

because it is a graphical method of analyzing the functional requirements of the system, and it is readily understood by people with a variety of backgrounds. This facilitates design review. The activity model -- which shows all of the functions, or activities, which the system must perform -- is independent of how a function is implemented. Any changes in the model can be made at this stage without the major changes to the system that would be required later. The completed activity model is easily reviewed by all concerned system users and any errors corrected.

Activity Model

Before drawing the activity model, the system is divided into its component functions. These are assigned node numbers and organized together to produce the initial breakdown of the system. Table I shows the node heirarchy. Explanations of each node follow.

Table I. Node Index.

A-0 Conduct Experiment and Process Data

- A1 Initialize Parameters
- A2 Determine Settings
- A3 Set Parameters
- A4 Acquire Data
- A5 Reduce Data

Node A-0, Conduct Experiment and Process Data (Figure 5)

This node is the top level model of the complete AHEEDAS. The system requirements are shown. User requirements for the Experimental Data Parameters are input (I1) from the terminal. When equipment is inoperative, the required data is manually read and entered from the terminal by an operator to simulate data readings from the automated equipment (I2). Actual data are input from the automated instrumentation (I3). Terminal entries (C1, C2 and C3) control the execution of the system. The dialogue is sent to the terminal (01); the experimental data parameters are then set by the hardware (02); the data are recorded and output to the terminal (03, 04, and 07), the disk (06), and the plotter (05). If manual input is required, a prompting message is displayed on the terminal (01).

The AHEEDAS will be able to complete a sample run unattended once all initialization is complete. The run time should be limited only by the experimental system's capacity for coolants (liquid helium). The operator need only assure that all systems are serviced prior to the start of execution.

Node A0, Conduct Experiment and Process Data (Figure 6)

Node A0 shows the decomposition of the node A-0 into five subordinate nodes,

A1 --- Initialize Parameters

A2 --- Determine Settings

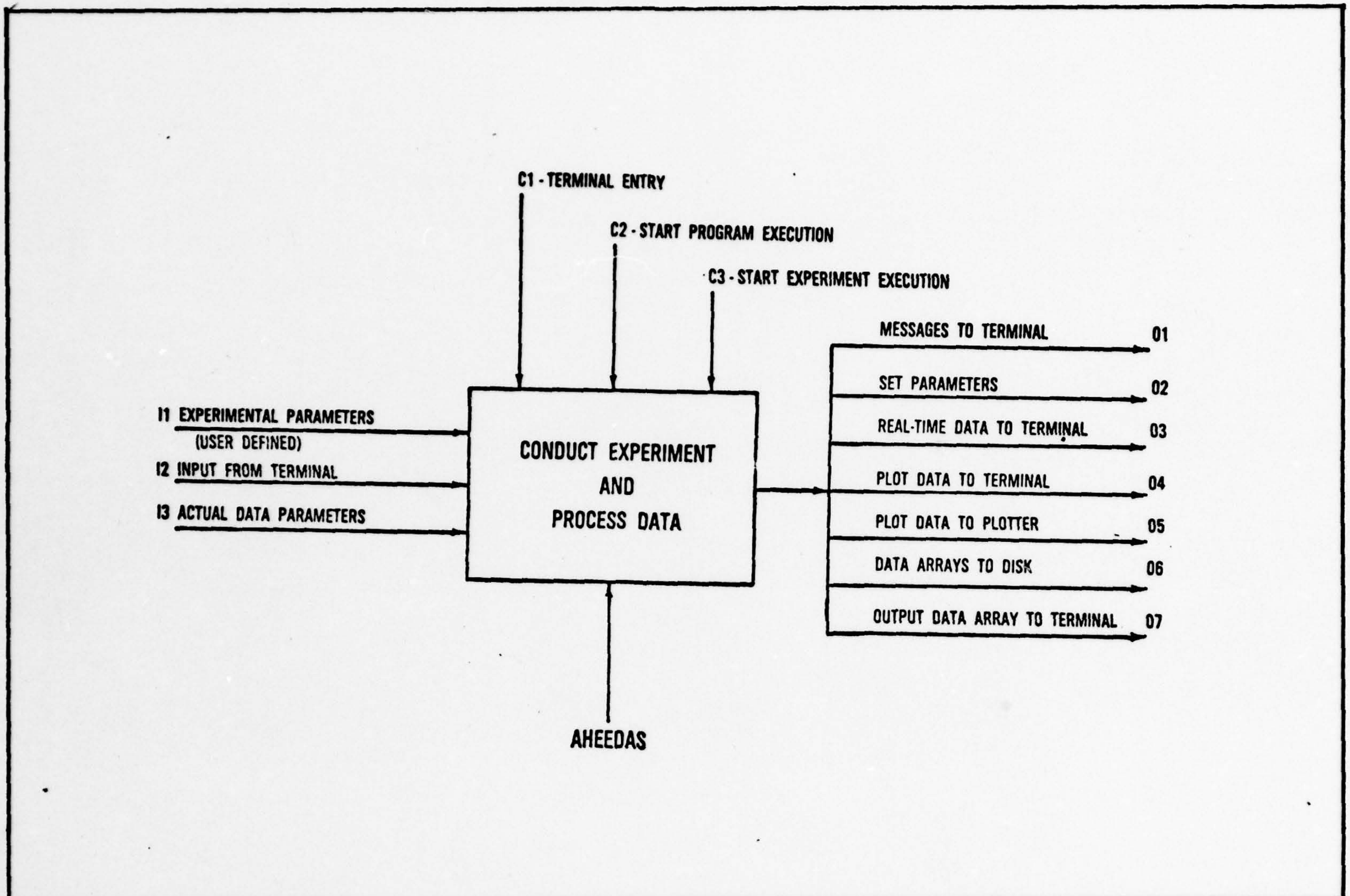

Figure 5. Node A-0 Conduce Experiment and Process Data

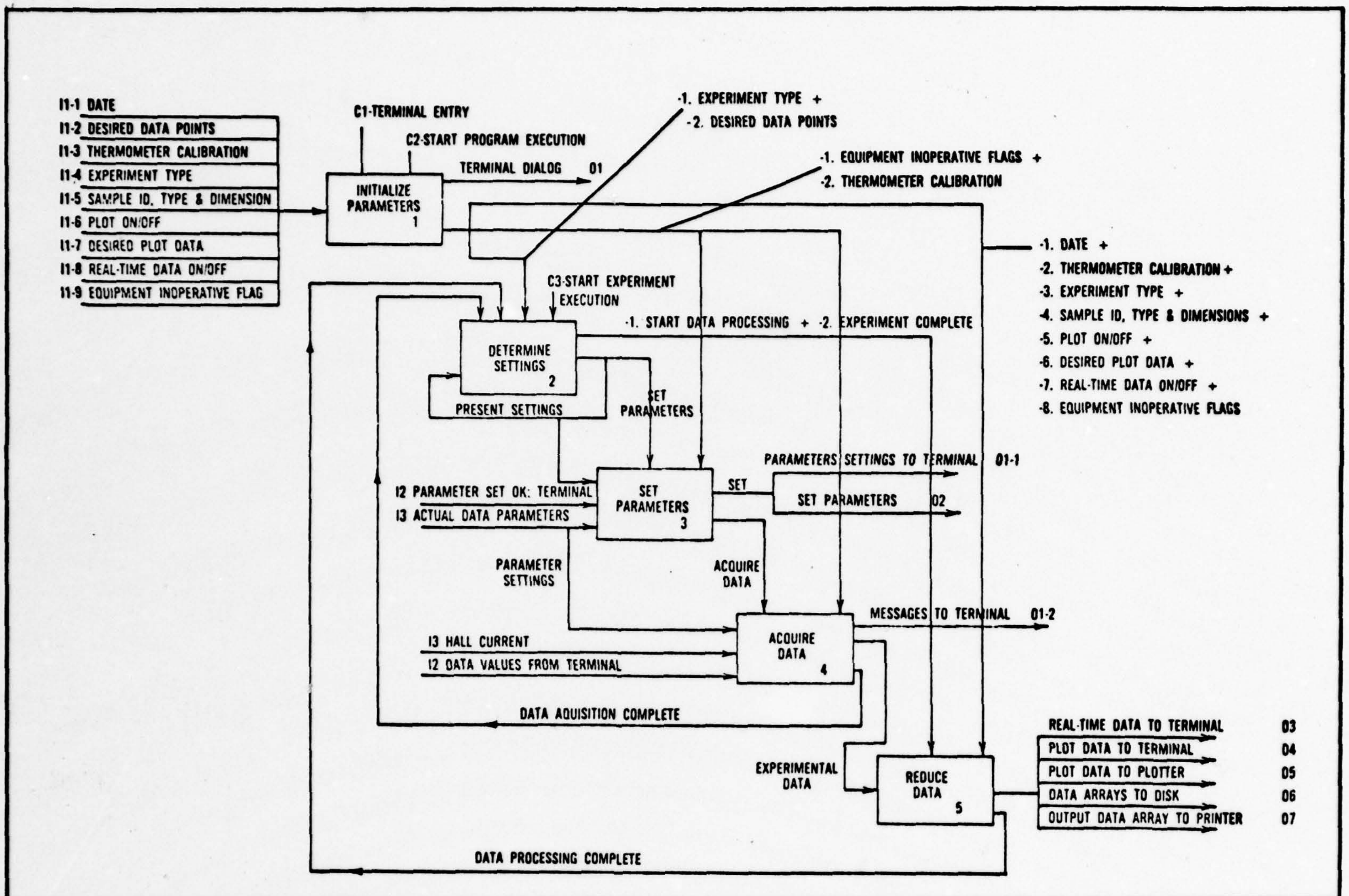

Figure 6. Node AO Conduct Experiment and Process Data

A3 --- Set Parameters

A4 --- Acquire Data

A5 --- Reduce Data

When the user starts execution, the activity Initialize Parameters interactively interrogates him to determine the required experimental parameters. Execution will then halt, allowing the user to make certain that the experimental equipment is ready to run, prior to starting the experiment.

The activity Determine Settings calculates the data parameters settings for each data point and passes them to the activity Set Parameters. Set Parameters makes sure that all parameters are properly set and generates the Start Data Acquisition signal. The activity Acquire Data is activated by this signal and reads all of the necessary data variables. Control is then passed back to Determine Settings which repeats the cycle. All of the data points at one temperature constitute a block of data. When a block of data is complete, the activity Reduce Data is called. Reduce Data calculates all of the necessary results and outputs these results and the data. Control is then passed back to Determine Settings to begin the next block of data.

Node A1, Initialize Parameters (Figure 7)

Node A1 is subdivided into five modules:

A11 --- Select Function

A12 --- Create Desired Data Points Files

A13 --- Create Thermometer Calibration Files

A14 --- Operator Initialization Dialogue

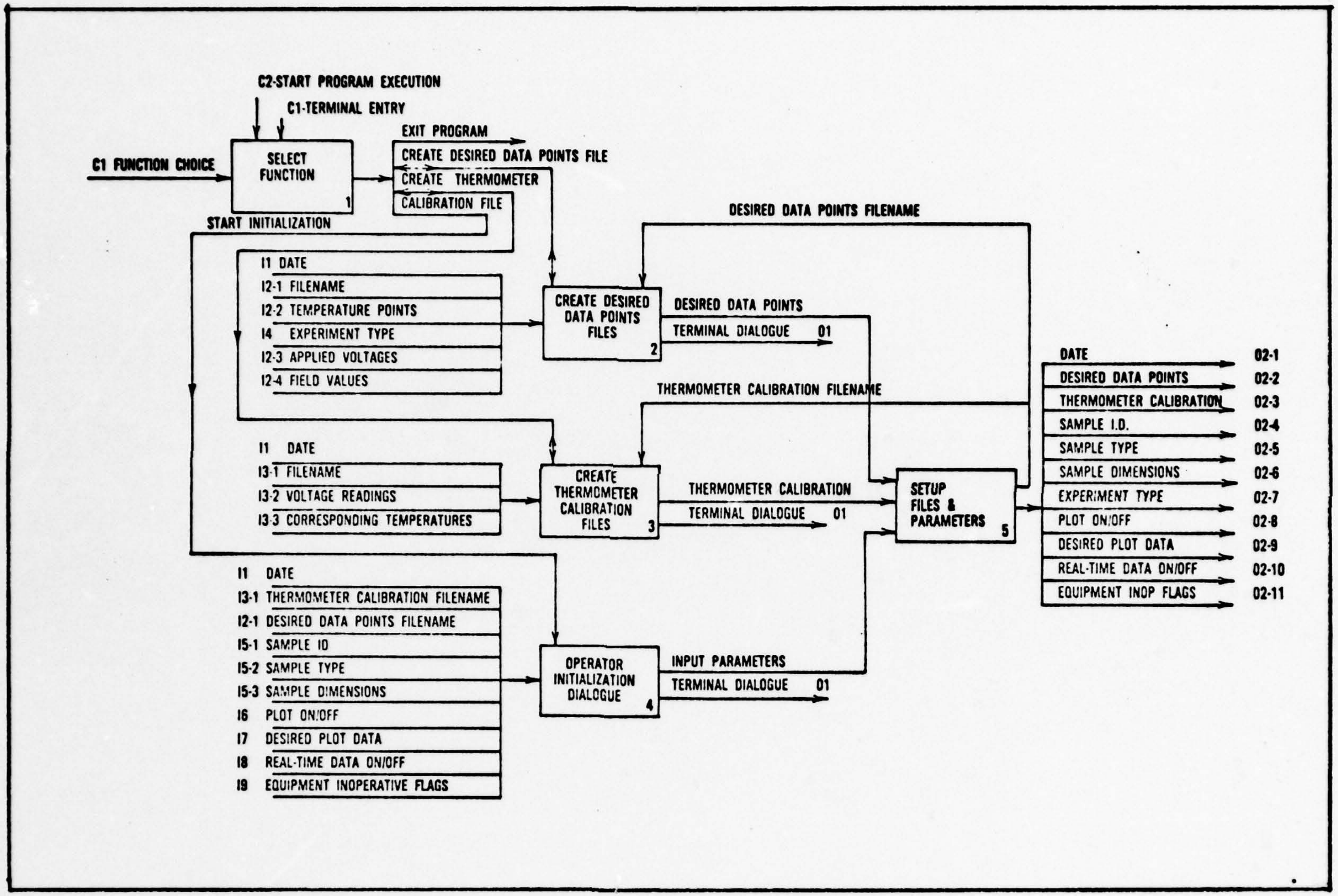

Figure 7. Node A1 Initialize Parameters

A15 --- Setup Files and Parameters

When Start Program Execution is received, the activity Select Function, asks the operator if he wants to

--- create a desired data points file

--- create a thermometer calibration file

--- run an experiment

--- exit the program

If "create a desired data points file" or "create a thermometer calibration file" is selected then the appropriate activity (A12 Create Desired Data Points Files or A13 Create Thermometer Calibration Files) done and control is returned to Select Function for a new selection. If "Run an Experiment" is selected, then the activity Operator Initialization Dialogue is executed. It interrogates the operator to determine all necessary experimental parameters. Control then passes to the activity Setup Files and Parameters, which initializes all needed experimental parameters and arrays and opens the necessary output files. The activity then pauses and informs the operator that initialization is complete and requests that he input a Start Execution command.

Node A2, Determine Parameters (Figure 8)

Node A2 is subdivided into five activities:

A21 --- Determine Temperature Settings

A22 --- Determine Field Settings

A23 --- Determine Sample Configuration Settings

A24 --- Determine Applied Voltage Settings

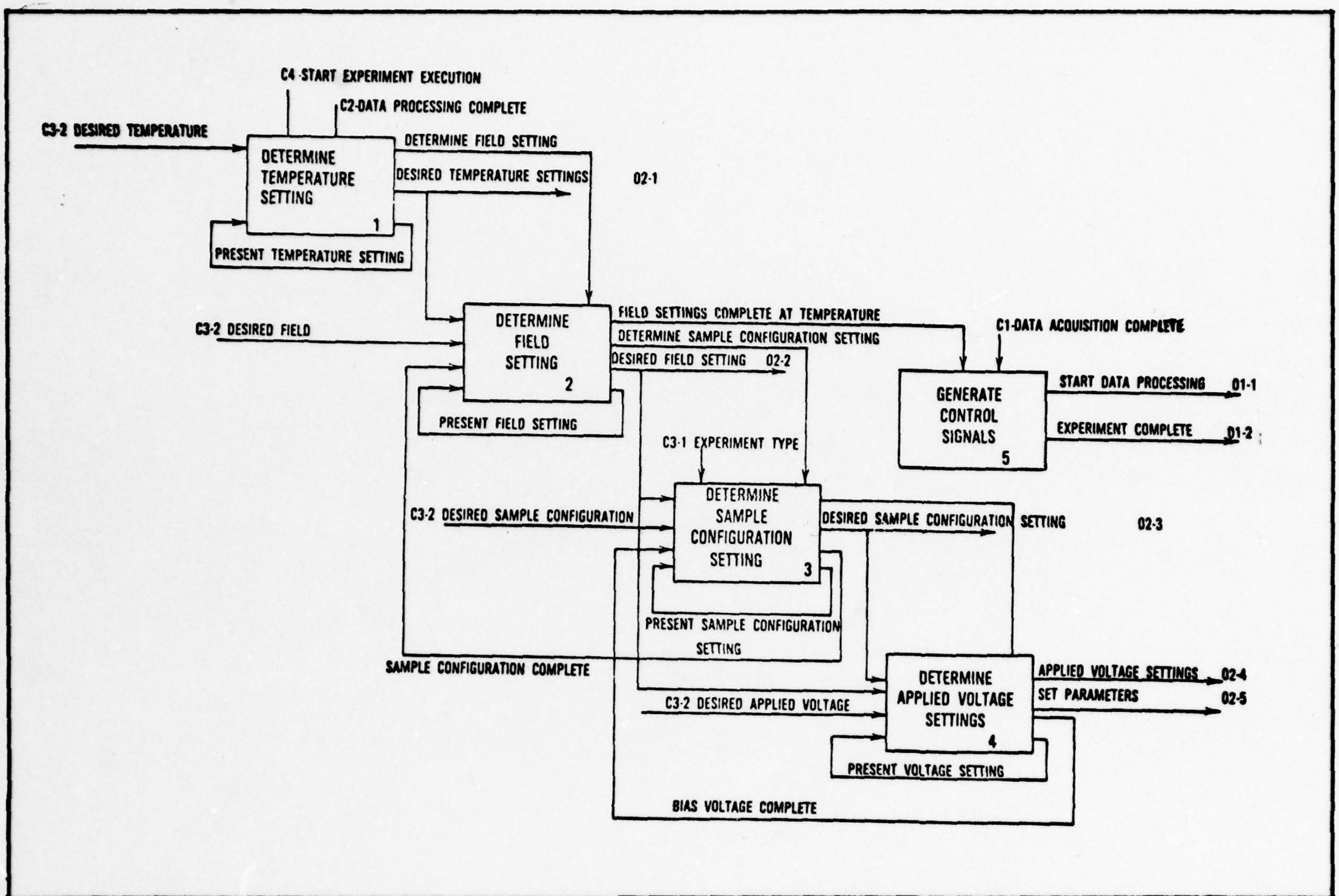

Figure 8. Node A2 Determine Settings

A25 --- Generate Control Signals

When experiment execution is begun, the activity Determine Temperature Settings receives control, performs its function and passes control to the activities Determine Field Settings, Determine Sample Configuration Settings, and Determine Applied Voltage Settings, in turn. This order is important. Each block of data is defined by a single temperature. Therefore, temperature must be determined first. The field magnitude is determined next, then sample configuration. The voltage setting changes at every data point. It, therefore, is determined last. This order allows the parameters that reach steady state the most rapidly to be reset the most often. Temperature and field, which take the longest to settle to their steady state value, are allowed to remain constant for as long as possible. When Determine Applied Voltage Settings completes its calculations, it then generates the Set Parameters signal. When all of the points at one temperature are complete, control passes to the activity Generate Control Signals, which sends out the Start Data Processing or the Experiment Complete signals, as appropriate.

<u>Node A3, Set Parameters</u> (Figure 9)

Node A3 is subdivided into six activities:

A31 --- Check/Set Field

A32 --- Check/Set Applied Voltage

A33 --- Check/Set Sample Configuration

A34 --- Check/Set Temperature

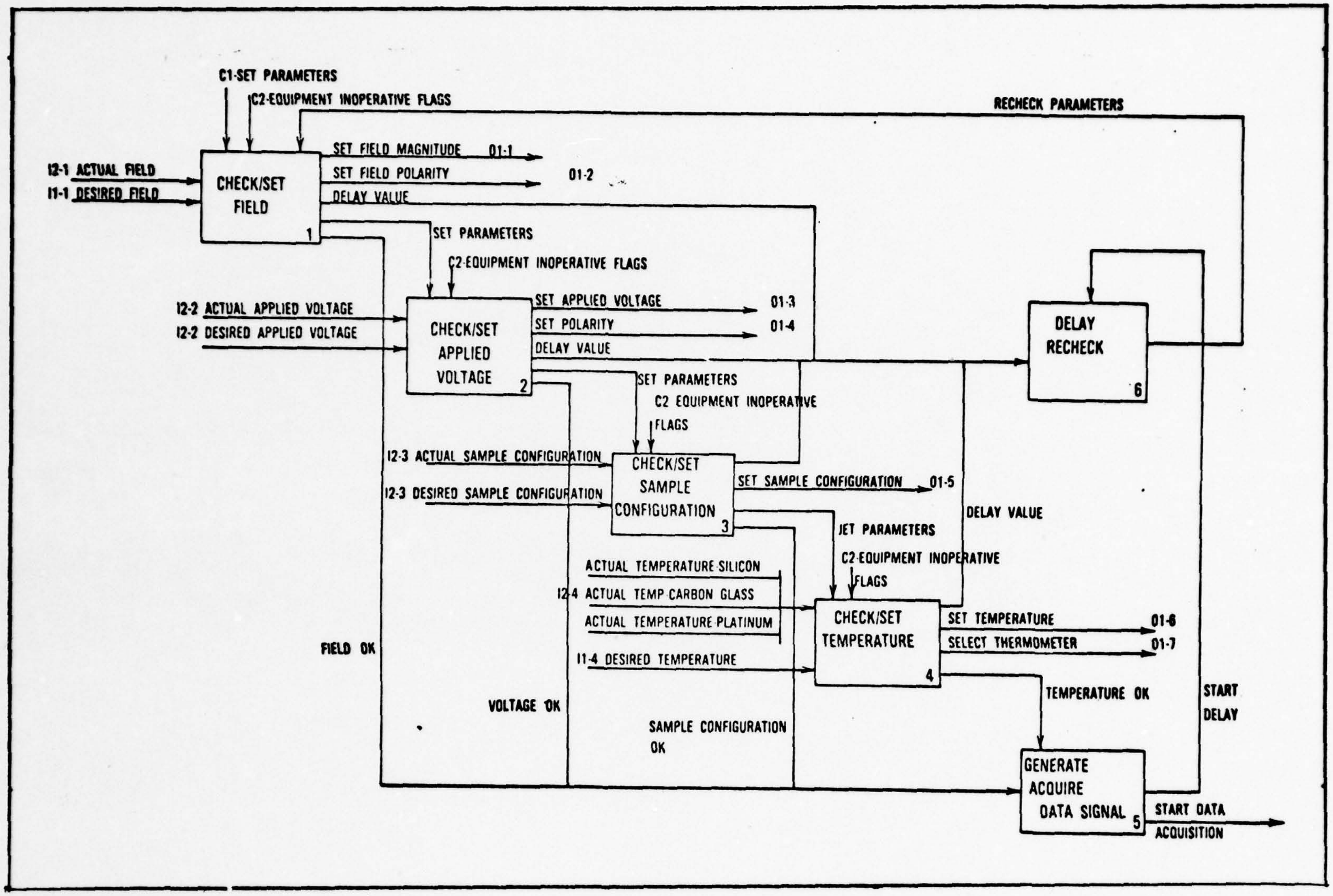

Figure 9. Node A3 Set Parameters

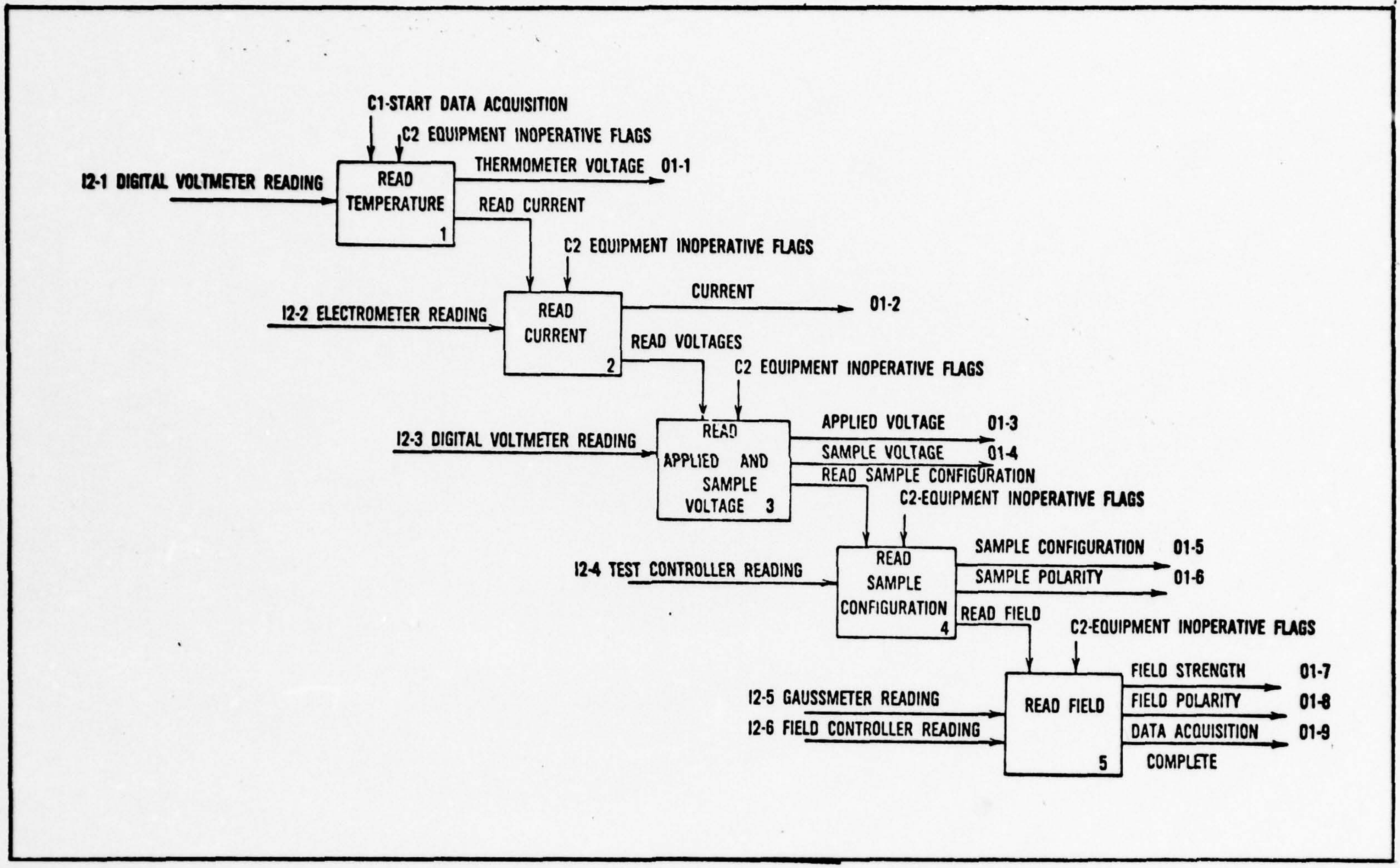

Figure 10. Node A4 Acquire Data

A35 --- Generate Acquire Data Signal

A36 --- Delay Recheck

When the Set Parameters signal is received, the activities Check/Set Field, Check/Set Applied Voltage, Check/Set Sample Configuration, and Check/Set Temperature each check the value of the parameters under their control. They each generate a setting if needed and generate either a value correct or an anticipated settling delay time signal. These modules execute serially in this order based on which are the most stable parameters. The most stable parameters are set first and left to settle to steady state. Temperature is the most unstable of the variables. As it varies, it affects the sample current and voltage readings. Therefore, it is set last so that a minimum of time will elapse after a parameter OK signal is generated and the Start Data Acquisition signal is sent. After Check/Set Temperature is through, it passes control to the activity Generate Acquire Data Signal, which checks whether all Value Correct signals have been received. If they have, the Start Data Acquisition signal is generated. If they have not, control is passed to the activity, Delay Recheck, which delays for the longest of the received delay time signals before passing control back to Check/Set Field to repeat the cycle until all values are correct. The Start Data Acquisition signal passes control to Node A4.

<u>Node A4, Acquire Data</u> (Figure 10)

Node A4 is subdivided into the following five functions:

A41 --- Read Temperature

A42 --- Read Current

A43 --- Read Applied Voltage and Sample Voltage

A44 --- Read Sample Configuration

A45 --- Read Field

When the Start Data Acquisition signal is received, the five activities read their parameters or, if their Equipment Inoperative Flag is set, request that the operator input the data reading from the terminal. While the order in which the data is taken is not extremely critical, the most unstable parameters, temperature and current, are read first whenever possible. When the field is on, temperature cannot be accurately read. Therefore, for these cases, the temperature is saved to last. All parameters except temperature are read, the field is turned to zero and temperature is then recorded. The data is stored in the data array and the Data Acquisition Complete signal is generated. This passes control back to node A2, Set Parameters, which repeats its function as previously discussed.

<u>Node A5, Reduce Data</u> (Figure 11)

Node A5 is subdivided into the following seven activities:

A51 --- Compute Temperature

A52 --- Compute Data Output

A53 --- Print Plot Data

A54 --- Plot Data

A55 --- Print Real-Time Data

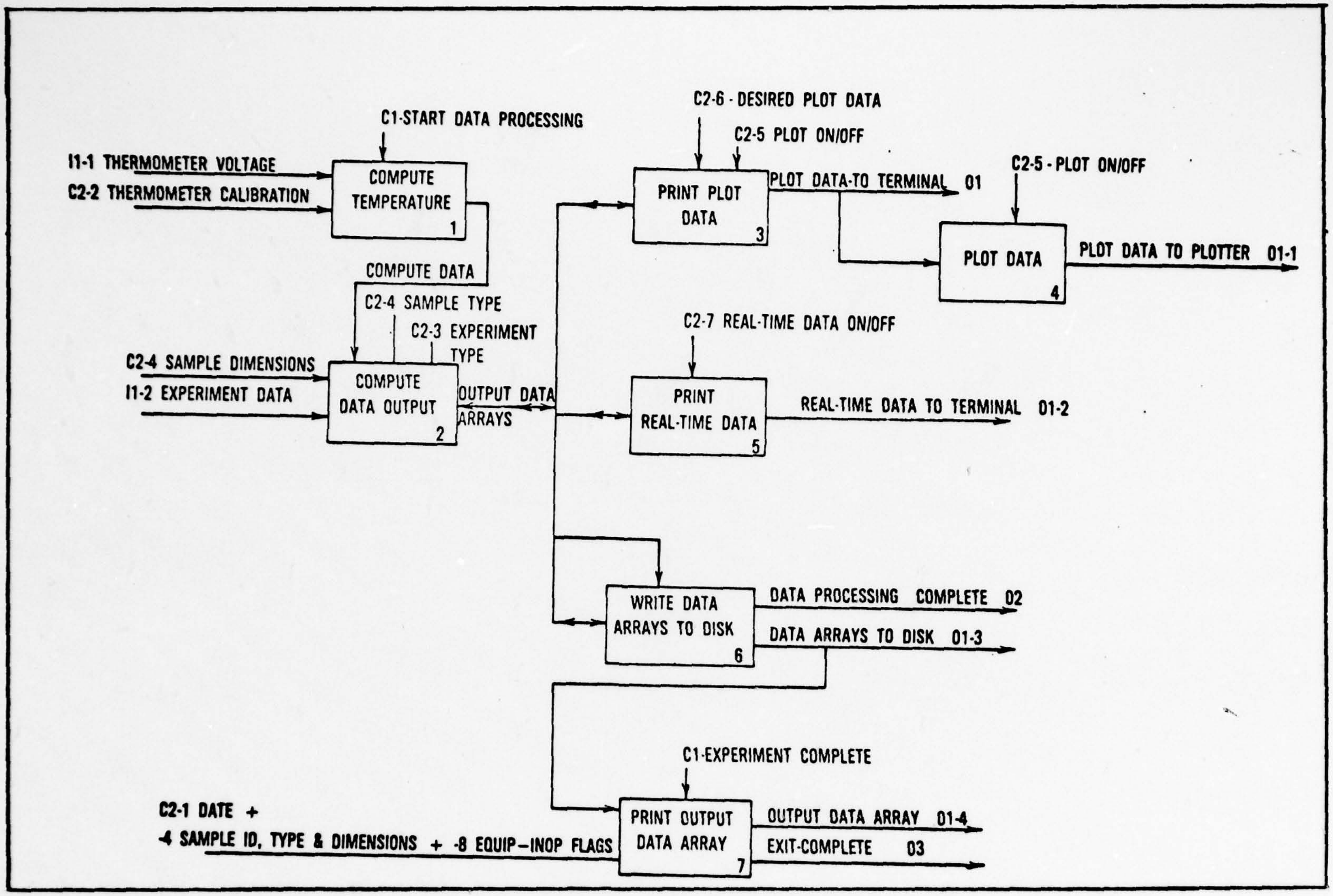

Figure 11. Node A5 Reduce Data

A56 --- Write Data Arrays to Disk

A57 --- Print Output Data Array

When the Start Data Processing signal is received from Node A2 (after the completing of each block of data), the activity Compute Temperature converts the voltage readings from the thermometer into the calibrated temperature values. Then, the activity Compute Data Output calculates all of the required output data (the composition of this output data was detailed in Chapter II, Theory). The appropriate data streams are then passed, as required, to the activities Print Plot Data and Plot Data, Print Real-Time Data, and Write Data Arrays to Disk, in turn. When A56 Write Data Arrays to the Disk is complete, the Data Processing Complete signal is generated. This passes control back to A2 Set Parameters. When the Experiment Complete signal is generated, control is passed directly to the activity Print Output Data Array. This module reads the complete Output Data Array from disk and outputs it to the terminal. It then terminates and control returns to the computer operating system.

Summary

In this chapter, the overall system requirements were defined. All activities that are to be accomplished by AHEEDAS have been documented. This design was presented to the sponsor, Dr. Patrick M. Hemenger, AFML/LPO. He concurred with the design. No engineering decisions that were not dictated by the system constraints, had been made at

this point. The next step is the design stage where detailed breakdowns of the activities may be used, if necessary, to facilitate design. Additional structure charts and flow diagrams will be used to document the algorithm design in Chapter IV.

IV. System Design and Implementation

After the requirements of the system were defined (see Chapter III), this definition had to be transformed into the actual design of the system. This design was guided by, but not completely bound by, the SADT definition. Several factors caused departures from the SADT design. Some modules were found to be trivial and were combined with other related modules. Some control signals were needed that were implemented differently from those on the SADT definition. The overall design is shown in heirarchical charts in Figures 12 and 13. In this chapter, the heirarchical design will be discussed along with the implementation of the algorithms.

Heirarchical Design

Figure 12 shows the overall AHEEDAS system. All system modules are shown excluding the implementation of the device drivers. This implementation is shown in Figure 13. These software modules correspond to the nodes of the SADT definition except for A44 Read Sample Configuration which was combined with A4 Acquire Data. Module A0 Conduct Experiment and Process Data is the executive for the AHEEDAS system. It contains all of the data specifications and it calls each of the five main submodules, A1 Initialize Parameters - A5 Reduce Data, as they are needed. All required intermodule data and control signals pass through A0 Conduct Experiment and Process Data.

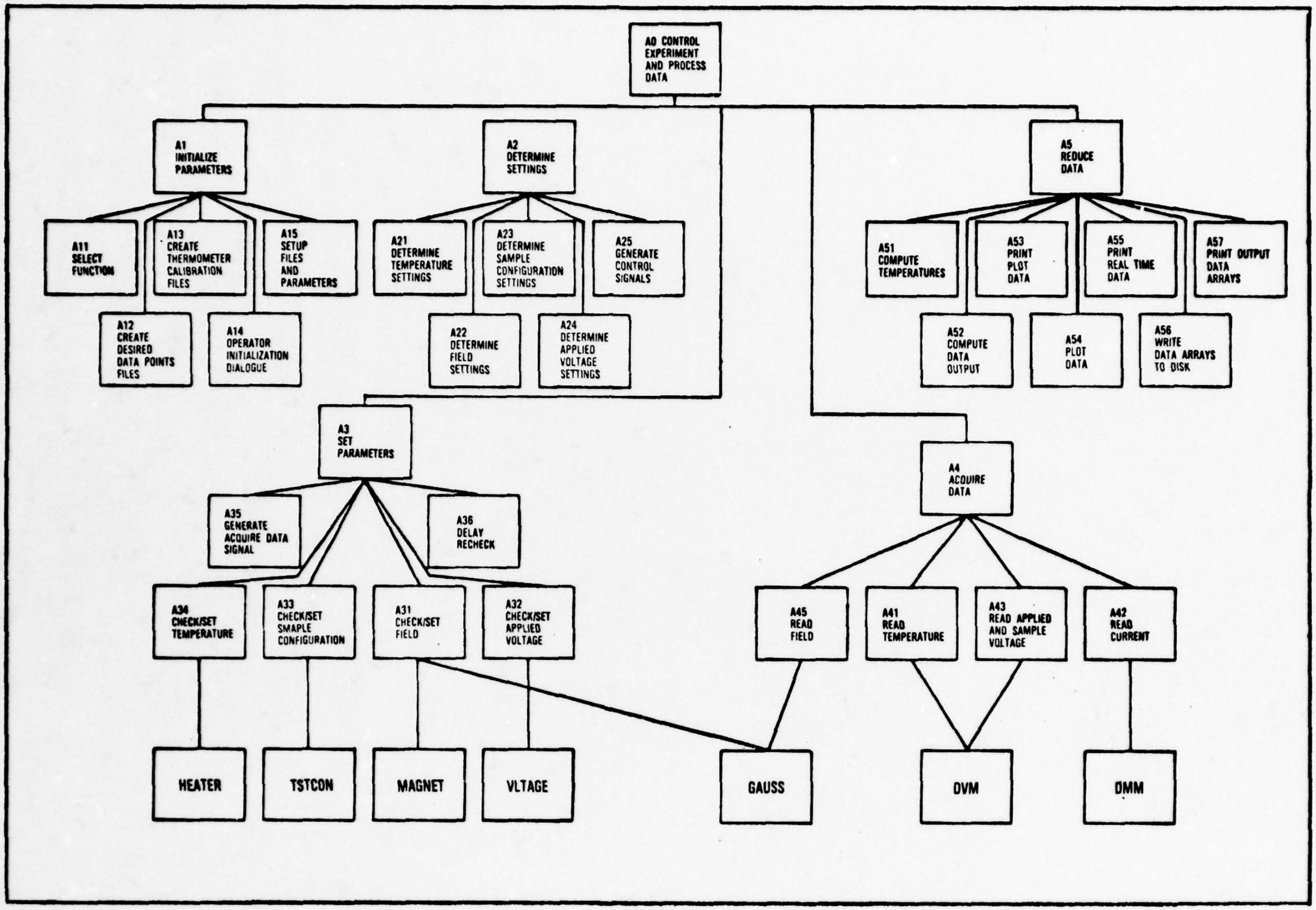

Figure 12. Heirarchical Chart of AHEEDAS

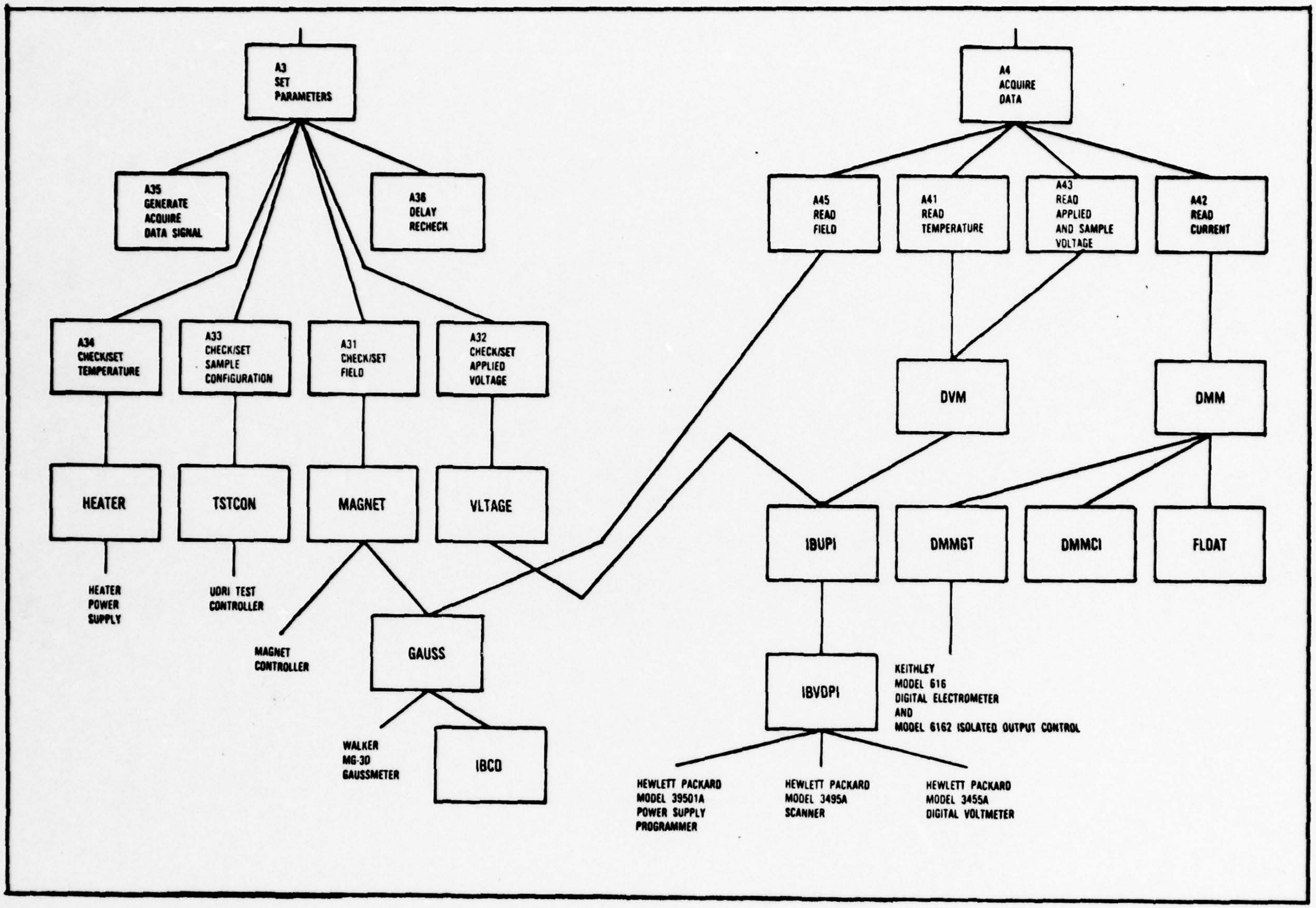

Figure 13. Heirarchical Chart of A3 and A4

Modules A1 Initialize Parameters - A5 Reduce Data are the second level executive modules for the system. They coordinate the flow of data and control signals between their subordinate modules.

Module A1 Initialize Parameters is the first module called by A0 Conduct Experiment and Process Data. It initially calls A11 Select Function which requests the user to enter his choice of what to do next. This choice is passed back to A1 Initialize Parameters which calls the appropriate function. Once initialization is complete (module A15 Setup Files and Parameters has finished), A1 Initialize Parameters returns to A0 Conduct Experiment and Process Data which calls A2 Determine Settings.

Module A2 Determine Settings calls each of its suborginate modules in turn to determine the initial data parameter settings. The data settings are also organized in an heirarchical manner. Therefore, each module will not need to be called each time that A2 Determine Settings is called to provide the parameter settings. Control signals are provided so that A2 Determine Settings can determine which modules need to execute for each run. When a block of data is complete A2 Determine Settings passes the Start Data Processing signal back to A0 Conduct Experiment and Process Data. A0 Conduct Experiment and Process Data will then call A5 Reduce Data. When A2 Determine Settings returns to A0 Conduct Experiment and Process Data without setting the Start Data Processing signal A0 Conduct Experiment and Process Data calls A3 Set Parameters.

A3 Set Parameters takes the parameter settings from AO Conduct Experiment and Process Data and calls each of its subordinate modules. The modules will then check to see if the value is already set and if it is not, will set the proper value by calling the appropriate device driver. The order in which these parameters are set is very important. A3 Set Parameters will not allow A31 Set Field to set the field if the field has other than a zero value, before the temperature is set. This is necessary because the field will affect the reading of the silicon thermometer which is used to set the temperature. As each module sets its parameter, it will pass a parameter OK signal to A3 Set Parameters. If the parameter needs time to settle to a steady state value, the module will not set the parameter OK true but will instead pass a settling delay time back. If all parameter OK signals are not received, A35 Generate Acquire Data Signal sets the delay value to the longest delay time requested by the other modules and returns to A3 Set Parameters. A3 Set Parameters then calls A36 Delay Recheck which waits the required amount of time and then returns. A3 Set Parameters then causes the Check/Set modules to execute again. When all four have executed A35 Generate Acquire Data Signal again checks the parameter OK signals and, if they are true, generates a Start Data Acquisition signal. The A34 Check/ Set Temperature module was implemented manually. As discussed in Chapter I, Constraints/Assumptions, the automated temperature controller could not be implemented within the scope of this study. Therefore, this module requests that

the temperature be set by the operator. He must then enter a signal that the temperature is set and at steady state. Because of the delay that this requires, the other settling delays are reset to zero whenever manual input is required. The operator's input signal is then treated like a parameter OK signal. When A3 Set Parameters returns to AO Control Experiment and Process Data, A4 Acquire Data is called to read the data.

Module A4 Acquire Data reads all of the required data parameters by calling A41 Read Temperature - A45 Read Field, in turn. A44 Read Sample Configuration was combined with A4 Acquire Data and does not execute separately. They read their parameters by calling the appropriate device interface drivers. As soon as A45 Read Field returns, A4 Acquire Data returns to AO Control Experiment and Process Data calls A2 Determine Settings which determines whether or not the data block is complete. If it is, A2 Determine Settings returns to AO Control Experiment and Process Data with the command to start data processing. AO Control Experiment and Process Data then calls A5 Reduce Data.

Module A5 Reduce Data first calls A51 Compute Temperatures to convert all of the temperature voltage data into temperatures. It does this by using a calibration table placed into memory by A1 Initialize Parameters. A55 Print Real-Time Data is called next, if the user has requested real-time data printout, to print out the raw data. Next A52 Compute Data Output is called to compute the remaining output data.

The calculations required for these data were discussed in Chapter II, Theory. A53 Print Plot Data is called next if the user has requested a plot. It prints the data pairs to be plotted. A54 Plot Data is then called to plot the data. A54 Plot Data is implemented as a non-functioning module because no printer has been purchased. When one is, the user will be able to implement it easily by putting the necessary software into this module. Up to four data pairs can be specified to be plotted. Then A56 Write Data Arrays to Disk is called to write all of the data to the disk files. If the experiment is complete (the Experiment Complete flag set true by A2 Determine Settings), A57 Print Output Data Array is called to print out all of the processed output data in tabular form. Otherwise, A5 Reduce Data returns to A0 Control Experiment and Process Data after executing A56 Write Data Arrays to Disk. A0 Control Experiment and Process Data then resets all of the control signals and settings for the next run.

Implementation

The software used to implement the above system are presented as listings in Appendix C. Listings of all modules are shown except for the National Instruments software which controls the IEEE 488 Instrumentation bus. This is available from National Instruments (Ref 1). Where needed, flow charts are included with each module to clarify its design. The main body of the algorithm (Node A0) was interfaced to the necessary device driver programs. In

writing the code, the author attempted to use structured code wherever possible. Named common was used for passing most of the parameters between subroutines. This allowed the parameters to be grouped into functional groupings and labeled. Additionally, the RT-11 operating system lists all named common blocks on the Link Map. This aided in debugging the programs and should aid in system maintenance. All of the subroutines pass control heirarchically. No direct calls are allowed between lower level modules. This eliminated confusion about control paths.

Method of Implementation

The language Fortran IV was used throughout the system design at the request of the user. The use of this higher order language will enable the user to more easily maintain the system. This implementation required a lot of memory space and, therefore, an overlayed program structure was required (Ref 20 and 21 describe the use of overlays in RT11 Fortran programming). A diagram of the overlay structure for AHEEDAS is shown in Figure 14.

To overlay a program the programmer must divide his program into several segments which do not have to be resident in memory simultaneously. A control or root segment must contain the main program, system library routines and any other program segments which must be present in memory at all times. The remainder of the program is divided into which need not be co-resident in core memory. The operating system swaps these segments in and out of memory from the desk

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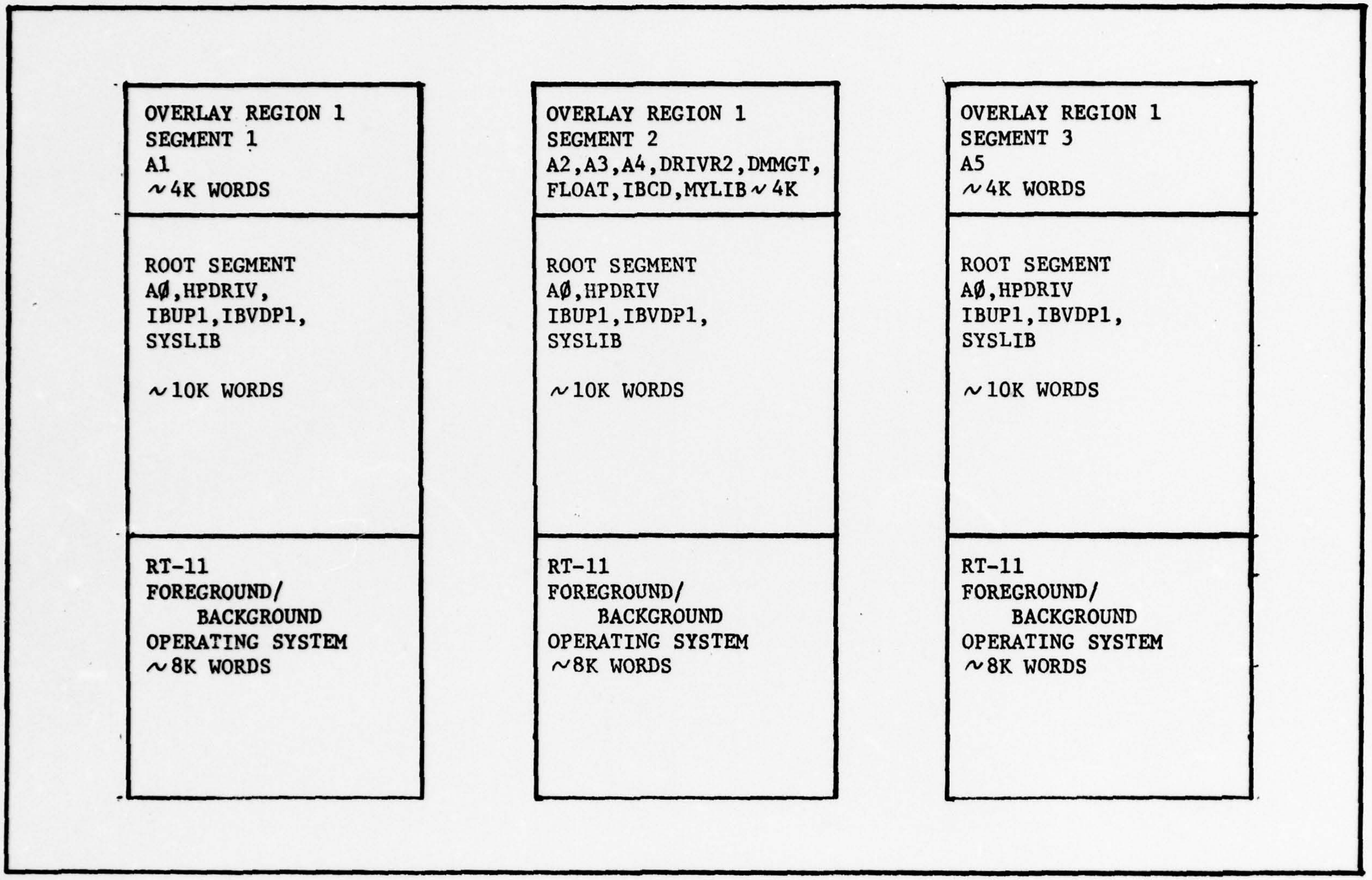

Figure 14. Overlayed Program Structure

from the disk storage unit as they are needed. Care must be taken to divide the program segments so that the segments are swapped as infrequently as possible. Otherwise, system performance will be seriously degraded by the large amount of system time spent swapping the overlays in and out of memory. This structure is very important. AO, any driver routines utilizing interrupts and the system library must be in the root segment. The division of the three segments of the overlay region is optimum for minimizing the overlay time. Any other structure resulted in an unacceptably high amount of time spent shifting the overlay segments in and out of memory.

V. System Testing and Validation

Any large system, such as AHEEDAS, must be tested in stages. The first stage was incremental testing to ensure that all levels of AHEEDAS would function. Next, the basic system was validated. The object of validation was to show that, if validation data were normally entered, AHEEDAS would produce the correct outputs. Then comes hardware testing in which all of the device drivers were functionally checked. Last, final validation was performed. To accomplish this, the entire AHEEDAS was integrated. The system was then used to run experiments of each type (see Chapter II for types). In this chapter, these stages of testing and validating the AHEEDAS will be discussed.

Incremental Testing

As the AHEEDAS was written, each module and submodule was tested individually. All modules were thus functionally tested prior to being integrated into the system. AHEEDAS was written and tested from the top down. This required A0 to be functionally tested with substitute submodules first. Then, the next level of modules was written and functionally tested with substitute modules for the third level. Next, each major module (examples: A1, A2, ...) was tested in its final form with all submodules, except the device drivers, included. Finally, all of the system modules were combined with small printing programs substituting for the actual equipment driver programs and the entire system was functionally tested. During functional testing, the primary

concern was to see that each activity executed as planned in the design and met the system requirements (reference Chapter III). Towards this end, extra output statements were used in the code to ensure that the modules were executing in the proper order and passing the proper parameters to each other. Functional testing alone, however, is not sufficient to validate the system operation.

Validation

To validate the system, it had to be confirmed that for all normal data inputs, the system produced correct results. To assure that the AHEEDAS was a valid system, the small substitute equipment drivers were again used in the system. These drivers allowed the operator to manually input the required data to the system. Past manual runs of the experiment were used to provide valid raw data inputs. This raw data had been reduced on the CDC 6600 computer and this output was used for comparison. The experimental raw data were entered through the substitute driver programs. The reduced data output was then compared with that from these past manual runs. (Since this was an algebraic validation, precise agreement was necessary. Because the degree of accuracy used was the same, there was no problem with the CDC 6600's greater accuracy capability.) Any discrepancies were traced and the problems corrected. The process was repeated until the data outputs of AHEEDAS agreed with the manual data outputs. Runs of all three experiment types were used: van der Pauw sample -- all sample configurations

used; van der Pauw sample -- abbreviated sample configurations (reference Chapter II, Original Environment); and Hall bar sample. The AHEEDAS provided valid outputs for all three types. The next step in the testing was then to connect the system to the actual hardware.

Hardware Testing

Before final implementation of the AHEEDAS, it was necessary to validate the interface of the hardware to the device driver programs. This was done by using a substitute test program which merely called the instrumentation to perform all of the functions that the AHEEDAS would require. Major problems were discovered in the IEEE 488 Standard Bus (National Instruments GPIB-11). National Instruments replaced both the interface card and the software drivers for this interface. This solved the problems with the bus. However, the interface has not been extensively used in the field and the documentation on its use is not complete. Future expansion of the system could uncover more problems. The magnet driver was an in-house produced interface. Numerous trials were necessary to get this interface to work properly. The Walker gaussmeter did not work properly. It functions erratically and should not be used in AHEEDAS until it is repaired. The AHEEDAS was designed to work with or without a functioning gaussmeter. The other interfaces worked properly with only minor problems which are corrected. When the proper functioning of these interfaces was confirmed, all that was left was to

test the full AHEEDAS in its final configuration.

Final Validation

Final validation was relatively simple. The LSI-11 and all associated hardware systems were connected into the final experimental configuration and experiments of each type were run. Data was then checked for reasonableness, consistency and, as far as possible, for accuracy. This was done by comparison with past manual experiments on similar samples. No point by point comparison was made. It was shown in Validation that for valid input, AHEEDAS produced valid output. The instrumentation used had been checked out in use for months. Therefore, it was assumed that the data input from the instruments was valid. The primary concern was the ability of the user to perform a complete experiment with consistent results. The users performed most of these tests under the guidance of the author. Thus, user familiarization was accomplished concurrently. No major problems were uncovered in this stage of testing. Minor corrections were all that were necessary to bring AHEEDAS to full functional status.

Summary

In this chapter, the process of validating the AHEEDAS was discussed. The AHEEDAS met all of the user's specifications for the first stage system. In the next chapter, the conclusions of this investigation will be discussed and recommendations for further study presented.

VI. Recommendations and Conclusions

During the course of this investigation, many problems were uncovered. New questions were raised. Not all of them were within the scope of this study to investigate. Recommendations for further investigation will be presented in this chapter. Then, the conclusions drawn from this study will be presented.

Recommendations

The design and implementation of the automated temperature control function of AHEEDAS remains to be accomplished. The temperature is currently controlled by an analog, closed-loop controller which supplies current to a heater element in the sample dewar. It gets feedback from its own uncalibrated thermometer elements and holds the voltage read from this thermometer constant by varying the heater current. The tolerance of this controller is approximately 0.01 degrees Kelvin. The user must use this controller and a separate voltmeter which reads a calibrated silicon thermometer to set a specific temperature. Two approaches appear to be the most promising. The first approach would be to use an existing computer controlled power supply to do the job. This would require the use of the same LSI-11 processor for temperature control that is used to run the rest of the experiment. It is not clear at the present time whether the temperature is stable enough to permit the use of this scheme. The differential between the temperature inside the sample dewar and the laboratory room temperature

can be as high as 290 degrees Kelvin at the low end of the temperature range. The temperature is very sensitive to the outside environment (for example, air currents caused by opening and closing doors or people walking by the apparatus affect the temperature). Since the activity of the analog controller is transparent to the user, how often the heater current must be adjusted to hold a constant temperature is not known. Experiments need to be conducted with a fully manual controller to determine the stability of the temperature. Another approach would be to use another processor to build a closed-loop temperature controller. A separate dedicated processor would be able to continuously adjust the heater settings to prevent the temperature from drifting. This controller would take the temperature setting from the LSI-11 and set the required value. This would free the LSI-11 to do other processing as required until interrupted by the controller when the temperature was at the proper steady state value. This appears to be the most desirable of the two options. However, it is not known at this time whether or not it is necessary to invest the extra money into the implementation of the second approach. Space was left in Module A3 Set Parameters to implement this function.

The user would like to add a plotting capability to the AHEEDAS. He desires that a four-color plotter be utilized. This device has not yet been purchased. The primary device being considered was listed in Chapter II in the list of the system hardware. A blank module was inserted into the

system for the software that will be needed for this interface. The plotter which has been tentatively specified, the HP7221A, will require a small driver to be written to control the system software that will be provided with the plotter.

AHEEDAS is a large system and required the use of an overlayed program structure to implement. The physical size of the algorithm could be considerably reduced if some of the driver modules had possibly some of the smaller system modules were written in MACRO-11, the system assembly language. The present system requires almost 16K words of memory. Over 4K words of useable memory remain. However, future system growth could mandate that some optimization of this type be done. If such optimization is done, the overlayed program structure discussed in detail in Chapter IV should be used for all future expansions. Any other structure will result in a considerable loss of time simply reading the overlay segments in and out of memory. Numerous options for optimizing program size are discussed in Reference 20. These compiler options can be used to reduce the program size with only small run time increases.

Once an experiment is complete, the output data from AHEEDAS still must be entered manually into the CDC 175 computer so that it may be analyzed in depth. AFML is presently installing a Prime Model 550, medium frame computer which is linked into the CDC computer. One of the purposes of this computer is to act as a buffer between the AFML minicomputer network and the CDC computer. The user

desires to interface to this computer via an acoustic coupler. The interface package to support this function needs to be developed so that the experimental data can be read directly into storage files in the CDC computer. The data could then be read directly into the analysis programs.

Conclusions

The AHEEDAS implemented is the first stage of a fully automated system. The initial design and implementation of this system were successfully completed. The LSI-11 microcomputer proved to be very satisfactory for the job. The initial software fulfilled the specifications for the first stage system (Ref Chapter 1). Time did not permit further investigation into the later steps in system development. Possible development for implementation in later stages of AHEEDAS were discussed in the recommendations in this chapter.

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Appendix A

Structured Analysis and Design Tool

Introduction

This appendix contains a brief explanation of the functional analysis phase of the Structured Analysis and Design Tool (SADT) to aid the reader in understanding the design development. A more complete discussion can be found in References 11 and 7. The method used here is a subset of the full tool. The explanation used below is condensed from Reference 18.

Structured Analysis

SADT is a comprehensive methodology for performing functional analysis and design. In the functional analysis phase, the emphasis is on analyzing and documenting the requirements on the system. A set of diagrams results which are called activity diagrams. They describe the system in terms of the activities it must perform. The diagrams are created by decomposing the system into smaller and smaller pieces. The completed set of diagrams provide a model of the system.

Diagram Syntax

SADT diagrams consist of labelled boxes and arrows for expressing the system activity and data models. Figure 15 illustrates the basic syntax of the model. Inside a box is the name of the activity model. This name expresses the action taking place.

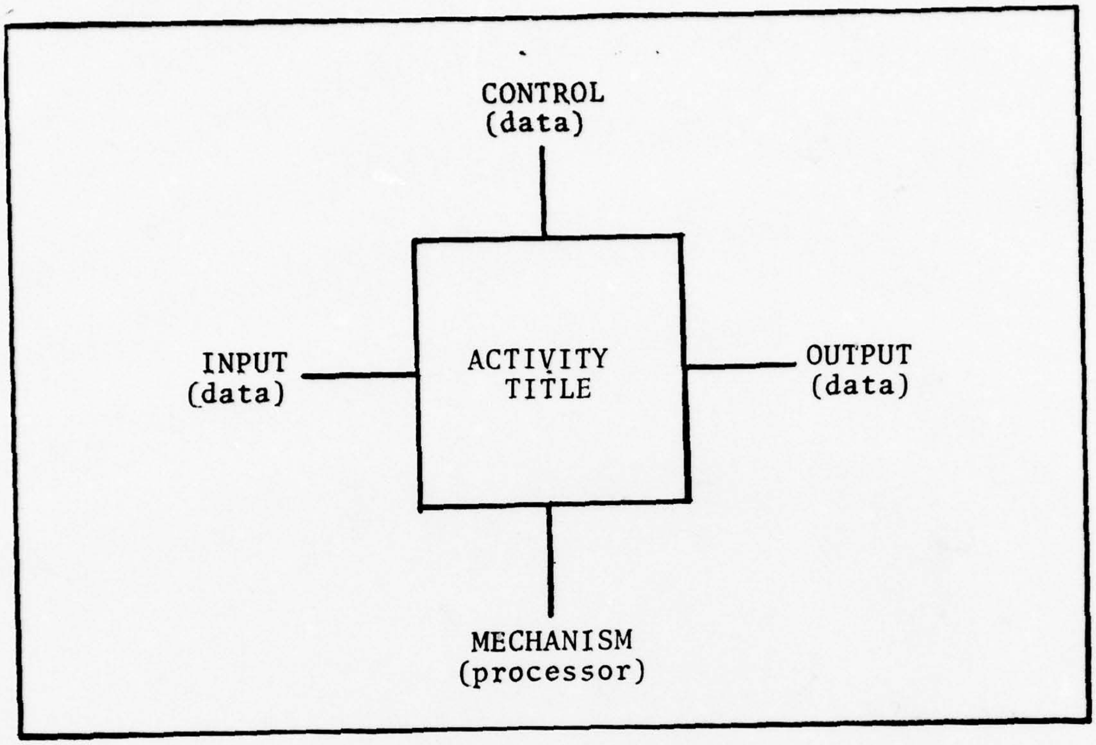

Figure 15. Box/Arrow Conventions

The boxes of the parent diagram are decomposed into more detailed diagrams called children. Each diagram is numbered in a Dewey-decimal manner (Ref 11:2-3) which represents the parent-child relationship. For example, diagrams 31, 32, 33 and 34 would be children of diagram 3. Each diagram is referenced as a node.

The boxes of a diagram are connected by arrows which represent the interface between the boxes. The sides of the box define the kinds of arrows which may enter or leave that side of the box.

Four types of arrows represent the kinds of interface. As in Reference 11:3-6, for activity diagrams these are:

Input: Data transformed by the activity into the output.

Output: Data created by the activity.

Control: Data used to control the process of converting the input into the output.

Mechanism: The processor which performs the activity.

It should be noted that the "mechanism" arrow represents the tool necessary to "realize the box" (Ref 11:3-4); since it is usually evident from the title of the box, the mechanism arrow is not always shown.

The "multiple branch" (EXCLUSIVE OR) is used to indicate multiple, but not simultaneous, outputs. The "multiple join" indicates, multiple but not simultaneous, inputs. Both conventions are shown in Figure 16. SADT also permits the use of simultaneous joining of signals into a pipeline of data.

An "ICOM" code is used to connect arrows across the parent/child boundaries. The name ICOM is derived from the arrow names: Input, Control, Output, and Mechanism. Each boundary crossing arrow (ones which do not have both ends connected to a box is labeled with its parent-context ICOM code, in addition to its normal label. This aids the reader in locating the matching parent arrow. The "ICOM" code is written near the unconnected end of the arrow and consists of the letter I, C, O, or M followed by a number. This number gives the relative position that the arrow enters or leaves the side of the parent box. Numbering is

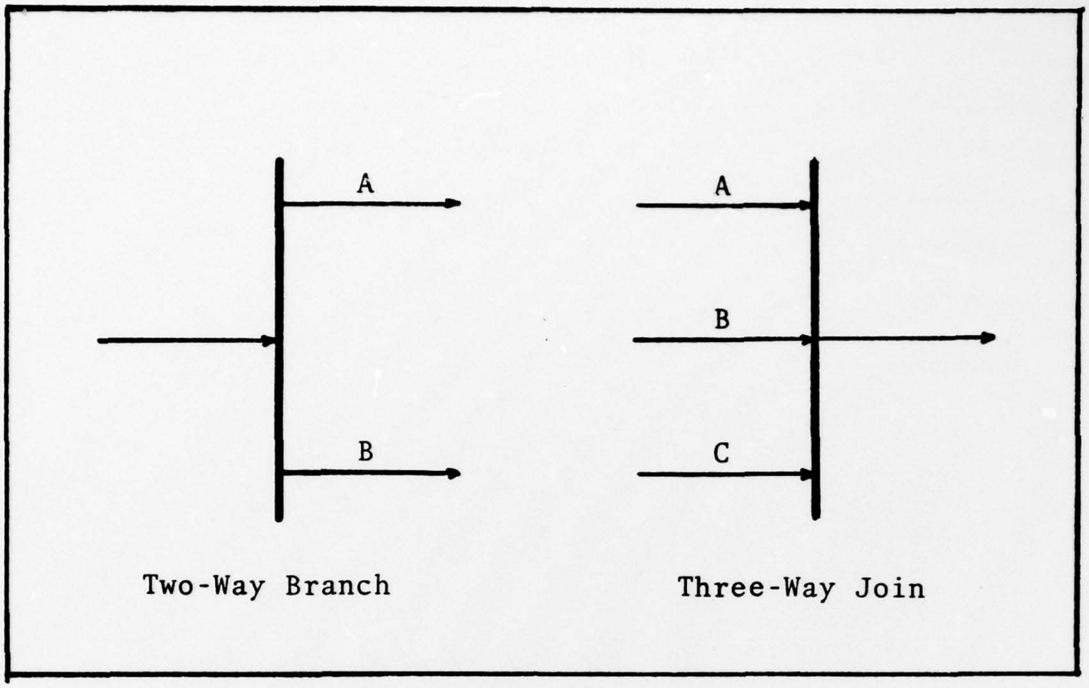

Figure 16. OR Branch and Join Structure

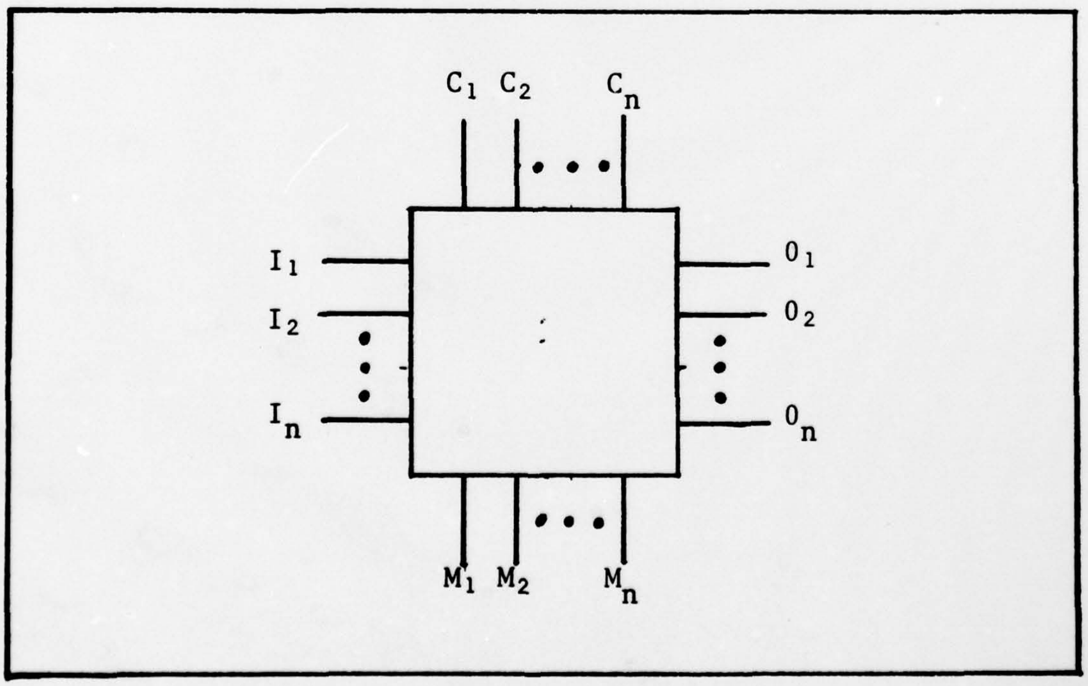

Figure 17. ICOM Numbering Convention

done from left to right and top-to-bottom as illustrated in Figure 17. For example, "C2" on an arrow in a child diagram indicated the arrow is the second control arrow entering the parent box.

In the text associated with each diagram, the arrows are identified with an "ICOM" code consisting of a letter (I, O, C, or M), a suffix number, and, where necessary for clarity, a dashed number referring to the position of the signal in a pipeline of data. The code refers to the box within the diagram and the suffix number refers to the top-down or left-right order of the arrow on the box. For example, "C2-6" refers to the sixth data item in a pipeline of data which entered the parent box at C2.

Appendix B

Operator's Manual for AHEEDAS

Every attempt has been made to make the AHEEDAS simple to use. Only a rudimentary knowledge of computer operation is needed to operate the system. A checklist of instructions for use of AHEEDAS follows.

I. Initialization

  A. Turn on power to all LSI-11 systems.

    1. Turn on power to the LSI-11 computer cabinet.
    2. Turn RUN/HALT switch on LSI-11 front panel to the RUN position.
    3. Turn ON/RTC switch to the ON position.
    4. Turn ON/POWER switch to the ON position.

  B. Put floppy disks into the system.

    1. Insert system disk into Drive 0 of the RX01 drive.
    2. Insert data disk into Drive 1.

CAUTION: THE DATA DISK MUST HAVE AT LEAST 130 CONTINUOUS FREE BLOCKS BEFORE STARTING AHEEDAS.

CAUTION: IF THE THREE DATA FILES RAWOUT.DAT, INTRMD.DAT, AND OUTPUT.DAT ARE PRESENT ON THE DISK, THEY SHOULD BE RENAMED BEFORE RUNNING AHEEDAS OR THEY WILL BE DESTROYED. RENAME FILES USING THE COMMAND RENAM DX1:RAWOUT.DAT DX1:Filename. THE DEVICE NAME MUST BE THE SAME FOR BOTH FILE SPECIFICATIONS.

C. Boot the system.

1. Type DX<cr> on the terminal.

2. When the system startup messages finish printing, type: DATE day-month-year (example: DATE 10-OCT-79) to enter the current date.

D. Run AHEEDAS.

1. Type: RUN DX):AHEDAS<cr> to start the system running.

2. The system will respond:

D(ATAFILE,T(EMCALFILE,I(NITIALIZE,Q(UIT

Enter the letter corresponding to your choice.

a. For choice D(ATAFILE and choice T(EMCALFILE respond to all system prompts to create the desired files. If disk space permits all such input files should be stored on the system disk in Drive 0 by entering the file specification:

DX0:Filename

when prompted for the filename.

b. Choice I(NITIALIZE should not be selected until after equipment turn on is complete.

E. Equipment Turn On and Initialization

1. Mount the sample and begin cool down procedure.

2. Turn on all necessary instruments.

a. HP3445A -- Digital Voltmeter, ensure that the proper input selected, front or back terminals.

b. HP3495A -- Scanner.

c. Keithley 616 Electrometer and 6162 Isolated Output Control -- Set sensitivity AUTO. FAST/NORMAL=FAST, RANGE==10**-11 Amperes.

d. Walker Gaussmeter -- set to 10,000 Gauss scale, ensure probe is installed to read proper field polarity.

e. Magnet and controller -- AUTO/MANUAL switch to AUTO, Field Selector=0.

f. UDRI Test Controller -- Set to AUTO.

g. Heater power supply and Artronix Controller.

h. Power supply to silicon thermometer.

i. Any other required equipment needed for this experiment.

3. If any of the automatic instrumentation is inoperative, the experiment can still be performed manually if a substitute piece of equipment is available. (Note: No substitute is needed for the gaussmeter as it is redundant.) The user must simply enter which piece of apparatus is inoperative and stand by to enter the readings manually.

F. Initialize Experiment

1. To begin initializing parameters for an experiment, respond to the prompt in D.2 above with choice 3. Respond to all system prompts for information and enter the appropriate entry for any inoperative system components when prompted. When

finished, the system will prompt:

INITIALIZATION IS COMPLETE

ENTER A 1 WHEN READY TO START EXPERIMENT

Before responding, recheck all experimental systems to assure that they are all turned on, warmed up, initialized and at steady state values. When finished, enter a 1<cr> to start the experiment.

II. Conduct Experiment

A. The AHEEDAS will execute the experiment using the the information you have given it. Each time that it needs a reading or an equipment setting done manually, it will ask for it by a prompt on the terminal. Make sure all data is entered carefully just as the system requests so that accuracy will be maintained.

CAUTION: IMPROPER ENTRY OF DATA CAN RESULT IN PROGRAM ABORT. TO RESTART, RE-EDIT DESIRED DATA POINTS FILE TO BEGIN AT FAILURE POINT, REINITIALIZE AND BEGIN AGAIN. BE SURE TO RENAME THE DATA FILES FROM THE FIRST ABORTED RUN OR THE SECOND RUN WILL DESTROY THEM.

III. Experiment Completion

A. AHEEDAS will output the data files and stop execution when finished.

B. Accomplish normal shutdown of all equipment when finished.

C. Shutdown LSI-11 computer.

1. Remove both floppy disk and store safely.
2. Move RUN/HALT switch to HALT.
3. Move ON/RTC switch to RTC.
4. Move ON/POWER switch to the down position (Note: All three switches should now be in the down position.)
5. Turn off power to the computer cabinet.

IV. To Interrupt Experiment

A. Turn 6162 Isolated Output off -- experiment will abort.

CAUTION: DO NOT ABORT EXPERIMENT USING CONTROL C (^C). THE DISK FILES WILL NOT BE SAVED. PROCEDURE IN IV.A WILL SAVE OUTPUT FILES.

B. Print output files, INTRMD.DAT, OUTPUT.DAT, and/or RAWOUT.DAT with utility program LISTER.SAV. (If Lister is used with a parallel printer, you must enter ASSIGN LP: 7: before running program.)

C. Execute normal shutdown (III).

Appendix C

AHEEDAS Program

This appendix contains the computer listings of the computer code used to implement the AHEEDAS. These modules correspond to those shown in Figures 12 and 13 in Chapter IV. Where needed for clarity, each module is preceded by a flow chart which outlines its functions. Modules A0 - A5 correspond to the Nodes A0 - A5 described in Chapter IV. Also shown are the device driver programs. The software modules IBUP1 and IBVDP1 (see Figure 13) are not shown. These programs were purchased from National Instruments (Ref 1 and 2). Several extensions to the RP-11 system library were also used. These were written by Mr. Frank E. Beital, University of Dayton Research Institute and are included in the AHEEDAS archives which are kept by the Air Force Materials Laboratory. Complete system listings and linking instructions can be obtained from Dr. Patrick M. Hemenger, AFML/LPO, Wright-Patterson AFB, Ohio 45433.

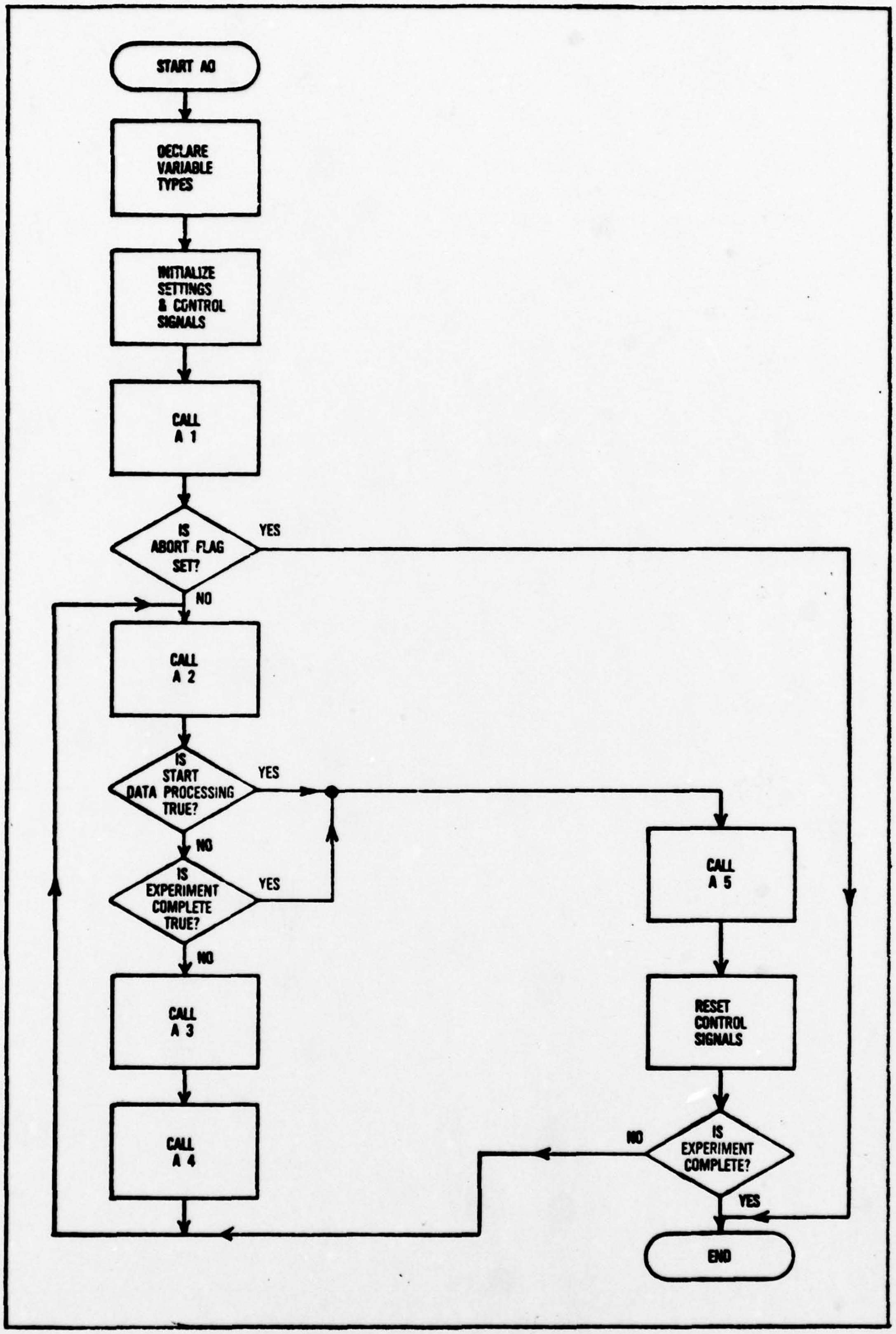

Figure 18. Flow Chart for Module AO

```
0001        PROGRAM A0
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C
      C MODULE A0---CONDUCT EXPERIMENT AND PROCESS DATA
      C
      C THIS MODULE IS THE TOP LEVEL EXECUTIVE FOR THE SYSTEM.  ITS FUNCTION IS
      C COORDINATE THE FUNCTIONS OF THE LOWER LEVEL MODULES AND TO
      C PASS THE DATA BETWEEN THEM.  ALL OF THE SUBROUTINE CALLS THAT PASS
      C FROM SINGLE DIGIT MODULES TO OTHER SINGLE DIGIT MODULES
      C WILL PASS THROUGH THIS COORDINATE MODULE.
      C
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
      C
      C HEADER
0002        BYTE TITLE(20),TODAY(9)
0003        REAL ITEMP(100)
0004        INTEGER TYPTEM
      C DATAIN
0005        REAL TEMP(100),FIELD,AVLT(2,6)
0006        INTEGER NTEMPT,ETYPE,NAVOLT,NDATPT
      C TCALIB
0007        BYTE THRMID(20)
0008        INTEGER NTEMP
0009        REAL TEMCAL(2,100)
      C SAMPLE
0010        BYTE SAMID(20)
0011        INTEGER SAMTYP
0012        REAL SAMT,SAMW,SAML
      C PLTOUT
0013        BYTE POPTS(6,11)
0014        INTEGER PLOTAB(4),PLOTOR(4),PLOT,NP
      C FILEIN
0015        BYTE TNAME(20),DPNAME(20)
      C EQPOUT
0016        BYTE EQUIPF(10,8)
0017        INTEGER IEIOF,EOFLAG(7)
      C CONTRL
0018        INTEGER ABORT
      C
      C RELTIM
0019        INTEGER RTDATA
      C
      C
      C
      C
      C     THESE ARE THE DATA SPECIFICATIONS FOR A2
      C
      C     CONSIG
0020        INTEGER SDP,EXPC,FSCOM,SCSCOM,VLTCOM
      C
      C  A2COM
0021        INTEGER NTEM,SCSET,SCOUNT,VCOUNT,RUN
```

```
0022        REAL TEMSET,FLDSET,VLTSET,X0
      C THESE ARE THE DATA SPECIFICATIONS FOR A3
      C   A3COM
0023        INTEGER FDELAY,SAM,FLDOK,TEMOK,VLTOK,SAMOK,
           2VDELAY,SDELAY,TDELAY,DELAY
0024        REAL FLD,VLT,TEM
      C DMMCOM
0025        REAL CRNTRD
      C GAUSSM
0026        REAL FLDRD
      C DVMCOM
0027        INTEGER FUNC
0028        REAL TEMRD,VLTRD
      C VLTPWR
0029        REAL VLTAGE
      C TSTCOM
0030        INTEGER SIGN
      C THESE ARE THE DATA SPECIFICATIONS FOR A4
      C     RAWDAT
0031        REAL TEMDAT(20),VLTDAT(20),SVDATA(20),FLDATA(20),IDATA(20)
0032        INTEGER SCDATA(20)
      C THESE ARE THE DATA SPECIFICATIONS FOR A5
      C DATOUT
0033        REAL RHO,P,MU,RH,F
0034        REAL TEMOUT(20),AVGTEM,DELTA,IATEM
0035        REAL R(4),R1R2,R3R4,R7,R8,VHALL,RMAG
0036        REAL R1,R2,R12,R5,R6,DELTAR,DELR5,DELR6
0037        REAL E,LN2,AFIELD,PI
      C PLOTER
0038        REAL PLOTS(4,2)
      C THESE ARE THE COMMON BLOCKS FROM MODULE A1
      C
0039        COMMON /HEADER/TITLE,ITEMP,TYPTEM,TODAY
0040        COMMON /DATAIN/NTEMPT,TEMP,ETYPE,FIELD,
           2NAVOLT,AVLT,NDATPT
0041        COMMON /TCALIB/THRMID,NTEMP,TEMCAL
0042        COMMON /SAMPLE/SAMID,SAMTYP,SAMT,SAMW,SAML
0043        COMMON /PLTOUT/PLOT,POPTS,NP,PLOTAB,PLOTOR
0044        COMMON /FILEIN/TNAME,DPNAME
0045        COMMON /EQPOUT/EOFLAG,EQUIPF,IEIOF
0046        COMMON /RELTIM/RTDATA
0047        COMMON /CONTRL/ABORT
      C THE NAMED COMMON BLOCKS FOR A2CMN FOLLOW.
0048        COMMON /CONSIG/SDP,EXPC,FSCOM,SCSCOM,VLTCOM
0049        COMMON /A2COM/TEMSET,FLDSET,VLTSET,X0,NTEM,SCSET,SCOUNT,
           2VCOUNT,RUN
      C THE COMMON BLOCKS FOR A3 FOLLOW
0050        COMMON /A3COM/FDELAY,VDELAY,SDELAY,TDELAY,DELAY,FLD,VLT,
           2TEM,FLDOK,TEMOK,VLTOK,SAMOK,SAM
0051        COMMON /DMMCOM/CRNTRD
0052        COMMON /GAUSSM/FLDRD
0053        COMMON /DVMCOM/FUNC,TEMRD,VLTRD
0054        COMMON /VLTPWR/VLTAGE
```

```
     C THE COMMON BLOCKS FOR A4 FOLLOW
0055       COMMON /RAWDAT/TEMDAT,VLTDAT,SVDATA,FLDATA,IDATA,SCDATA
     C THE COMMON BLOCKS FOLLOW FOR A5
0056       COMMON /DATOUT/RHO,P,MU,RH,F,TEMOUT,AVGTEM,DELTA,IATEM,R,
          2R1R2,R3R4,R7,R8,VHALL,RMAG,R1,R2,R12,R5,R6,DELTAR,DELR5,DELR6,
          3E,LN2,AFIELD,PI
0057       COMMON /PLOTER/PLOTS
     C INITIALIZE ALL REQUIRED CONTROL SIGNALS AND DATA SETTINGS
     C
0058       DATA TEMSET/0.0/
0059       DATA NTEM,SCSET,FLDSET,VLTSET,SCOUNT,VCOUNT/1,0,0.0,0.0,0,0/
0060       DATA FLD,VLT,SAM,TEM,RUN/0.0,0.0,0,0.0,0/
     C NOW GO TO THE INITIALIZATION MODULE
     C
0061       CALL A1
     C
     C
     C CHECK IF ABORT FLAG IS SET
     C
0062       IF(ABORT.EQ.1)GO TO 900
     C
     C NOW BEGIN THE EXPERIMENT---CALL DETERMINE SETTINGS
     C
0064 20    CONTINUE
0065       CALL A2
     C
     C TEST TO SEE IF START DATA PROCESSING IS TRUE
     C
0066       IF(SDP.EQ.1)GO TO 800
     C
     C
     C TEST TO SEE IF EXPERIMENT IS COMPLETE
     C
0068       IF(EXPC.EQ.1)GO TO 800
     C
     C CALL SET PARAMETERS
     C
0070       CALL A3
     C
     C START DATA ACQUISITION
     C
0071       CALL A4
     C
     C GO BACK TO A2
     C
0072       GO TO 20
     C
     C CALL REDUCE DATA
0073 800   CONTINUE
0074       CALL A5
     C RESET ALL CONTROL SIGNALS AND SETTINGS FOR THE NEXT RUN
0075          VLTSET=0.0
0076          FLDSET=0.0
```

```
      SCSET=0
      SDP=0
      RUN=0
      VLTCOM=0
      SCSCOM=0
      VCOUNT=0
      IF(ETYPE.EQ.1)SCOUNT=0
C
C IF EXPERIMENT IS COMPLETE EXIT
      IF(EXPC.EQ.1)GO TO 900
      GO TO 20
900   CONTINUE
      STOP
      END
```

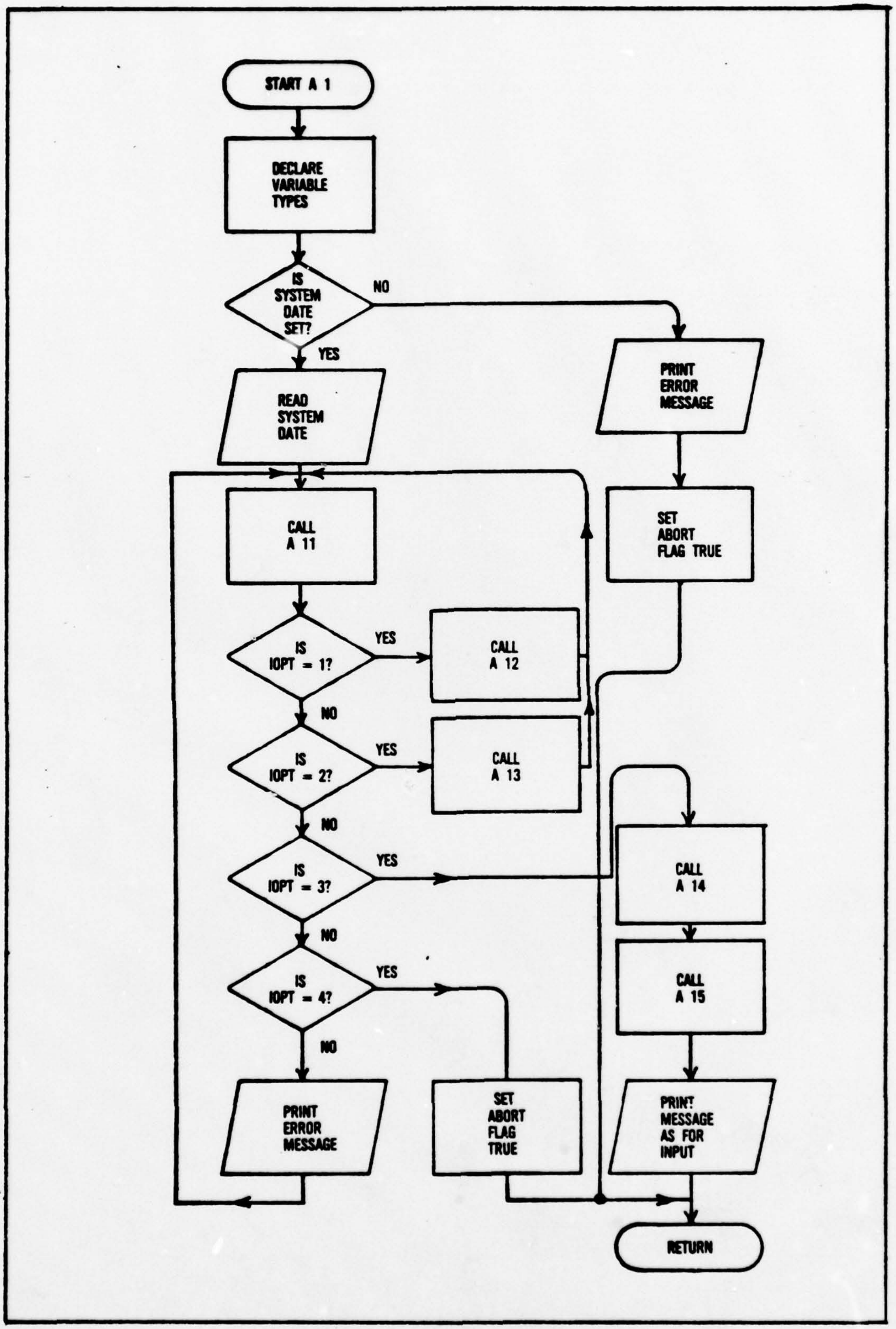

Figure 19. Flow Chart for Module A.

```
      SUBROUTINE A1
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C
C  MODULE A1--INITIALIZE PARAMETERS
C    A1---CONTROLS MODULES A11-A15
C
C      THIS MODULE CONTROLS THE INITIALIZATION MODULE.
C A USER RUNS THE PROGRAM AND IS REQUESTED BY A11 TO SUPPLY A
C NUMBER WHICH DIRECTS THE PROGRAM TO EXECUTE ONE OF FOUR
C OPTIONS:
C
C           1.  CREATE A DESIRED DATA POINTS FILE.
C
C           2.  CREATE A THERMOMETER CALIBRATION FILE.
C
C           3.  INITIALIZE PARAMETERS FOR AN EXPERIMENT.
C
C           4.  STOP EXECUTION OF THE PROGRAM.
C
C AFTER CREATION OF EITHER A DESIRED DATA POINTS FILE OR A THEMOMETER
C CALIBRATION FILE THE PROGRAM RETURNS TO THE USER AND REQUESTS HIS
C NEXT OPTION.  AT THIS TIME HE MAY CREATE ANOTHER FILE
C OR BEGIN INITIALIZATION OF PARAMETERS FOR THE EXPERIMENT OR STOP.
C IF HE STOPS HIS FILES WILL REMAIN ON THE DISK HE SPECIFIED FOR USE
C AT A FUTURE TIME.  IF HE ELECTS TO INITIALIZE THE EXPERIMENTAL
C PARAMETERS THEN MODULES A14 AND A15 EXECUTE.  UPON COMPLETION
C THE PROGRAM HALTS UNTIL THE USER GIVES THE COMMAND TO BEGIN THE
C EXPERIMENT EXECUTION.  PRIOR TO ISSUING THIS SIGNAL THE USER
C SHOULD ENSURE THAT ALL OF THE EQUIPMENT IS TURNED ON AND
C READY TO GO.  IF NOT INFORMED VIA THE EQUIPMENT OUT FLAGS THE
C COMPUTER CANNOT TELL WHETHER THE INSTRUMENTS ARE ON LINE OR
C NOT.  ONCE TOLD TO PROCEED WITH THE EXPERIMENT
C A1 WILL PASS CONTROL TO A2--DETERMINE DATA PARAMETERS VIA THE
C COMMAND MODULE A0.  EXECUTION WILL THEN PROCEED TO EXPERIMENT
C COMPLETION
C
C                      AUTHOR:  CAPTAIN EDGAR A. VERCHOT,JR.,USAF
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C
C
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C
C HEADER
      BYTE TITLE(20),TODAY(9)
      REAL ITEMP(100)
      INTEGER TYPTEM
C DATAIN
      REAL TEMP(100),FIELD,AVLT(2,6)
      INTEGER NTEMPT,ETYPE,NAVOLT,NDATPT
C TCALIB
```

```
      BYTE THRMID(20)
      INTEGER NTEMP
      REAL TEMCAL(2,100)
C SAMPLE
      BYTE SAMID(20)
      INTEGER SAMTYP
      REAL SAMT,SAMW,SAML
C PLTOUT
      BYTE POPTS(6,11)
      INTEGER PLOTAB(4),PLOTOR(4),PLOT,NP
C FILEIN
      BYTE TNAME(20),DPNAME(20)
C EQPOUT
      BYTE EQUIPF(10,8)
      INTEGER IEIOF,EOFLAG(7)
C CONTRL
      INTEGER ABORT
C
C RELTIM
      INTEGER RTDATA
C
C
C
C   A11COM
      INTEGER IOPT
      INTEGER ERRET,MONTH,DAY,YEAR
C THESE ARE THE COMMON BLOCKS FROM MODULE A1
C
      COMMON /HEADER/TITLE,ITEMP,TYPTEM,TODAY
      COMMON /DATAIN/NTEMPT,TEMP,ETYPE,FIELD,
     2NAVOLT,AVLT,NDATPT
      COMMON /TCALIB/THRMID,NTEMP,TEMCAL
CC
C
      COMMON /SAMPLE/SAMID,SAMTYP,SAMT,SAMW,SAML
      COMMON /PLTOUT/PLOT,POPTS,NP,PLOTAB,PLOTOR
      COMMON /FILEIN/TNAME,DPNAME
      COMMON /EQPOUT/EOFLAG,EQUIPF,IEIOF
      COMMON /RELTIM/RTDATA
      COMMON /CONTRL/ABORT
      COMMON /A11COM/IOPT
C
      DATA EQUIPF/'D','M','M',' ',' ',' ',' ',' ',' ',' ',
     2           'D','V','M',' ',' ',' ',' ',' ',' ',' ',
     3           'H','T','R',' ','P','W','R',' ',' ',' ',
     4           'B',' ','V',' ','P','W','R',' ',' ',' ',
     5           'M','G','N','T',' ','C','N','T','L','R',
     6           'T','E','S','T',' ','C','N','T','L','R',
     7           'G','A','U','S','S',' ','M','T','R',' ',
     8           0,0,0,0,0,0,0,0,0,0/
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
```

```
      CALL IDATE(MONTH,DAY,YEAR)
      IF (MONTH.EQ.0)GO TO 310
      CALL DATE(TODAY)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
10    CONTINUE
      CALL A11
         IF(IOPT.NE.1)GO TO 20
            CALL A12
            GO TO 10
20       CONTINUE
         IF(IOPT.NE.2)GO TO 30
            CALL A13
            GO TO 10
30    CONTINUE
         IF(IOPT.NE.3)GO TO 40
            CALL A14
            CALL A15
            GO TO 50
40    CONTINUE
        IF(IOPT.NE.4) GO TO 800
         GO TO 900
50    CONTINUE
      WRITE(7,1010)
1010  FORMAT( //' INITIALIZATION IS COMPLETE'/
     2         ' ENTER A 1 WHEN READY TO START EXPERIMENT')
      READ(5,*) IGO
      GO TO 910
C  ERROR MESSAGES
800   CONTINUE
          WRITE(7,8000)
8000      FORMAT( /,' ILLEGAL ENTRY, TRY AGAIN')
      GO TO 10
C
C  ERROR MESSAGE FOR NO SYSTEM DATE SET
C
810   CONTINUE
      WRITE(7,8010)
8010  FORMAT( /,' YOU DID NOT SET THE SYSTEM DATE.'/
     2        ' THE PROGRAM WILL ABORT.'/
     3        ' SET THE DATE AND RESTART.')
         GO TO 900
900   CONTINUE
C
C SET THE ABORT FLAG TO END THE PROGRAM
C
      ABORT=1
910   CONTINUE
      RETURN
      END
```

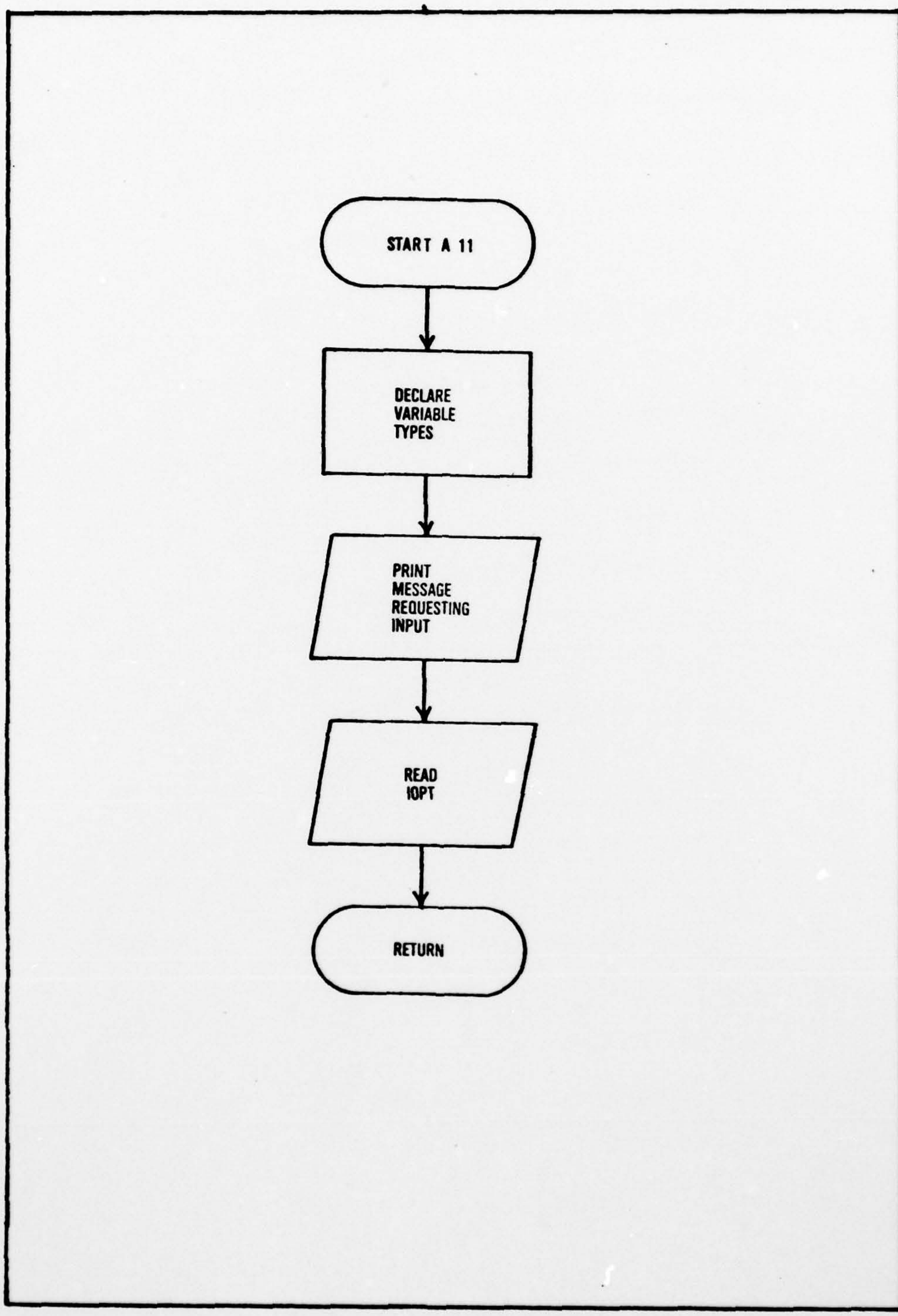

Figure 20. Flow Chart for Module A11

```
      SUBROUTINE A11
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A11---SELECT FUNCTION
C
C      THIS MODULE QUERIES THE USER FOR HIS CHOICE OF FUNCTIONS.  THE
C USER CAN EXECUTE ONE OF THE FOLLOWING FOUR OPTIONS:
C
C     1.  CREATE A DESIRED DATA POINTS FILE.
C
C     2.  CREATE A THERMOMETER CALIBRATION FILE.
C
C     3.  INITIALIZE PARAMETERS FOR AN EXPERIMENT.
C
C     4.  STOP EXECUTION OF THE PROGRAM AND EXIT.
C
C      THIS CHOICE IS RETURNED TO A1 WHICH EXECUTES IT.
C
C
C                   AUTHOR:  CAPTAIN EDGAR A VERCHOT,JR., USAF
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C DATA SPECIFICATIONS FOR A11
      BYTE CMND
      INTEGER IOPT
      COMMON /A11COM/ IOPT
C
C  ASK FOR SELECTION CHOICE
10    CONTINUE
      WRITE(7,1000)
1000  FORMAT(/,' D(ATAFILE,T(EMCALFILE,I(NITIALIZE,Q(UIT',$)
      READ(5,2000,ERR=800) CMND
2000  FORMAT(1A1)
      IF(CMND.EQ.'D')IOPT=1
      IF(CMND.EQ.'T')IOPT=2
      IF(CMND.EQ.'I')IOPT=3
      IF(CMND.EQ.'Q')IOPT=4
      GO TO 900
800   CONTINUE
         WRITE(7,8000)
8000     FORMAT(' ILLEGAL ENTRY')
         GO TO 10
900   CONTINUE
      RETURN
      END
```

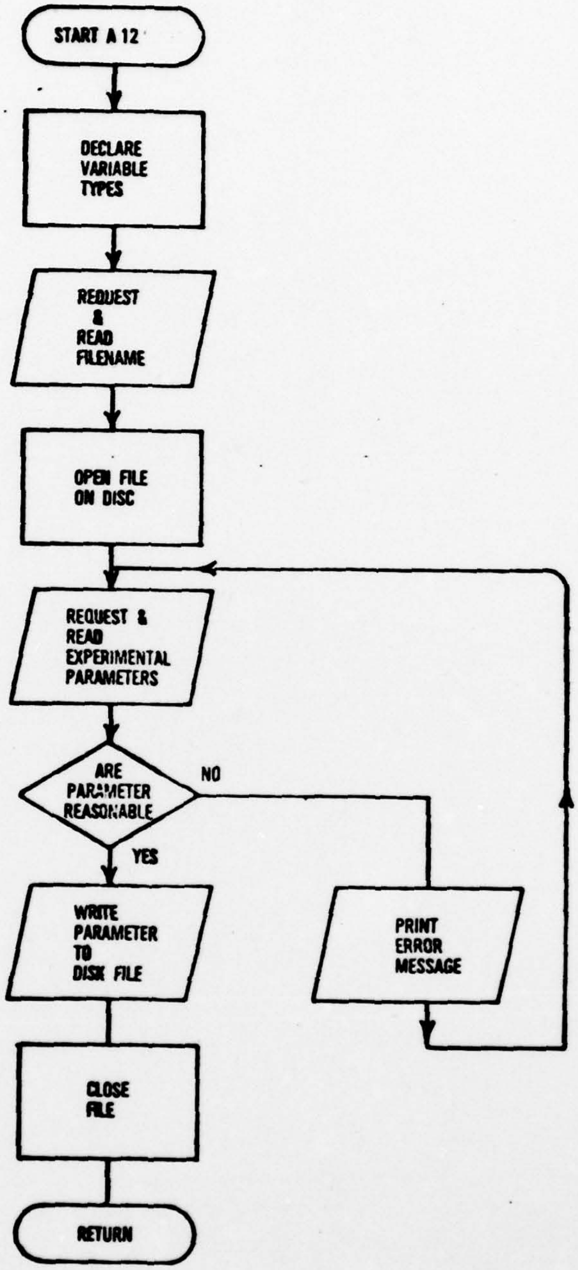

Figure 21. Flow Chart for Module A12

```
      SUBROUTINE A12
C
C     THIS PROGRAM IS TO CREATE THE DESIRED INPUT DATA FILE
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C    MODULE A12--CREATE DESIRED DATA POINTS FILES
C
C
C     THIS MODULE IS AN INTERACTIVE ROUTINE WHICH GUIDES THE USER
C TO CREATE A FILE ON THE DISK TO CONTAIN THE DESIRED DATA
C PARAMETERS FOR AN EXPERIMENTAL RUN.  THE USER MUST FIRST
C SUPPLY A FILENAME TO USE ON THE APPROPRIATE DISK.  SINCE THESE
C FILES CAN BE RETAINED FOR REUSE FOR AN EXTENDED PERIOD OF TIME,
C DX0: IS THE PREFERRED DISK IF THERE IS STORAGE SPACE.  OTHERWISE
C DX1: SHOULD BE USED.  THE FORMAT TO BE ENTERED IS,
C        DX1:VDPDAT.ONE.
C ANY APPROPRIATE NAME IN THIS FORMAT CAN BE USED.  THE PROGRAM
C THEN REQUESTS THE USER TO ENTER A ONE LINE(80 CHARACTER) EXPERIMENT
C TITLE.  THE EXPERIMENTOR IS THEN ASKED TO SPECIFY WHETHER HE
C WISHES TO USE TEMPERATURE POINTS OR INVERSE TEMPERATURE POINTS.
C FOLLOWING THIS THE NUMBER OF DESIRED TEMPERATURE DATA POINTS
C IS REQUESTED.  THE DATA POINTS ARE ENTERED NEXT.  THEY CAN BE
C ENTERED IN ONE OR MORE LINES BUT EACH ENTRY SHOULD BE FOLLOWED
C BY A COMMA EXCEPT THE LAST.
C UP TO 100 POINTS CAN BE SPECIFIED.
C THE EXPERIMENT TYPE IS REQUESTED NEXT.  THIS PARAMETER SPECIFIES
C WHAT SAMPLE CONFIGURATIONS WILL BE USED:
C           TYPE "1" DOES ALL OF THE VAN DER PAUW SAMPLE POSITIONS
C                AT EACH TEMPERATURE(POSITIONS:1,2,3,4,5,6).
C              TYPE "2" DOES  SAMPLE POSITIONS(1,2,5)
C                AT THE ODD TEMPERATURE POINTS AND THE REMAINING
C                SAMPLE POSTIONS(3,4,6) AT THE
C                EVEN TEMPERATURES.
C              TYPE "3" DOES THE EXPERIMENT WITH THE HALL BAR SAMPLE.
C NEXT, THE APPLIED VOLTAGES ARE REQUESTED.  UP TO SIX CHANGES OF APPLIED
C VOLTAGE CAN BE SPECIFIED.  THE USER MUST SPECIFY THE TEMPERATURE AT
C WHICH THE APPLIED VOLTAGE IS TO BE CHANGED AND THE VALUE TO WHICH
C IT WILL BE CHANGED.  FIRST THE NUMBER OF PAIRS OF VALUES WILL BE REQUESTED
C THEN THE PAIRS WILL BE REQUESTED INDIVIDUALLY.
C     LAST THE NECESSARY FIELD VALUE IS NEEDED.
C     ALL OF THESE VALUES ARE WRITTEN TO THE DISK FILE IN THE
C SAME FORMAT THAT IS ENTERED.  ALL OF THESE INPUT/OUTPUT
C OPERATIONS ARE DONE IN FREE FORMAT.
C
C
C                    AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C
```

```
     C HEADER
0002       BYTE TITLE(20),TODAY(9)
0003       REAL ITEMP(100)
0004       INTEGER TYPTEM
     C DATAIN
0005       REAL TEMP(100),FIELD,AVLT(2,6)
0006       INTEGER NTEMPT,ETYPE,NAVOLT
     C FILEIN
0007       BYTE TNAME(20),DPNAME(20)
     C
     C
     C
     C THESE ARE THE COMMON BLOCKS FROM MODULE A1
     C
0008       COMMON /HEADER/TITLE,ITEMP,TYPTEM,TODAY
0009       COMMON /DATAIN/NTEMPT,TEMP,ETYPE,FIELD,
          2NAVOLT,AVLT
     C
0010       BYTE ERRFLG
0011       INTEGER ERRET
     C
     C
     CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
     C
     C
     C
0012 10    WRITE(7,1000)
0013 1000  FORMAT( /,' ENTER FILE NAME IN FORMAT EX: DX1:VDPDAT.ONE   ',$)
0014       CALL GETSTR(5,DPNAME,19,ERRFLG)
     C
0015       OPEN(UNIT=1,NAME=DPNAME,TYPE='NEW')
     C
0016       WRITE(1,1210) TODAY
0017 1210  FORMAT( 9A1)
0018       WRITE(7,1002)
0019 1002  FORMAT( /,' ENTER EXPERIMENT TITLE IN 19 CHARACTERS'/' *', $)
0020       CALL GETSTR(5,TITLE,19,ERRFLG)
0021       WRITE(1,1003) (TITLE(I),I=1,LEN(TITLE))
0022 1003  FORMAT(80A1)
     C
     C  CHECK TO SEE IF TEMPERATURE OR INVERSE TEMPERATURE IS USED
     C
0023       ASSIGN 500 TO ERRET
0024 500   CONTINUE
0025       WRITE(7,1011)
0026 1011  FORMAT( /,' INPUT A "0" IF TEMPERATURE WILL BE USED',/,
          1' OR A "1" IF INVERSE TEMPERATURE WILL BE USED   ',$)
0027       READ(5,*) TYPTEM
0028       WRITE(1,*) TYPTEM
     C  CHECK FOR ERROR
0029       IF(TYPTEM.NE.0.AND.TYPTEM.NE.1)GO TO 900
     C     NOW GET THE TEMPERATURE POINTS TO BE TAKEN
     C
```

```
C     FIRST GET THE NUMBER OF TEMPERATURES TO BE USED
C
      ASSIGN 510 TO ERRET
510   CONTINUE
      WRITE(7,1005)
1005  FORMAT( /,' ENTER NUMBER OF TEMPERATURE POINTS TO BE TAKEN ',/
     1' BETWEEN ONE AND ONE HUNDRED    ' $)
      READ(5,*,END=20)NTEMPT
      WRITE(1,*)NTEMPT
      IF(TYPTEM.NE.0) GOTO 40
C CHECK FOR ERROR
      IF(NTEMPT.LT.1.OR.NTEMPT.GT.100)GO TO 910
C
C      NOW GET THE VALUES OF TEMPERATURE THAT WILL BE USED
C
C
C
      WRITE(7,1020)
1020  FORMAT( /,' ENTER THE DESIRED TEMPERATURES    ')
      READ(5,*,END=20)(TEMP(J),J=1,NTEMPT)
C
      WRITE(1,*)(TEMP(J),J=1,NTEMPT)
      GO TO 45
C?
C     GET THE DESIRED INVERSE TEMPERATURE POINTS
C
C
40    CONTINUE
      WRITE(7,1012)
1012  FORMAT( /,' ENTER THE DESIRED INVERSE TEMPERATURES',/,
     1' SEPARATED BY COMMAS.  USE UNITS OF 1000/TEMPERATURE  ')
      READ(5,*) (ITEMP(J),J=1,NTEMPT)
C
      WRITE(1,*) (ITEMP(J),J=1,NTEMPT)
45    CONTINUE
C
C
C
C    NOW GET THE EXPERIMENT TYPE
C
C
      ASSIGN 520 TO ERRET
520   CONTINUE
      WRITE(7,1035)
1035  FORMAT( /,' ENTER ZERO IF YOU NEED OPTIONS ON EXPERIMENT TYPE,
     1    OTHERWISE ENTER 1    ',$)
      READ(5,*) K
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      IF(K.NE.0)GOTO 50
        WRITE(7,1040)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
1040    FORMAT(
```

```
     1      ' THE TYPE SPECIFIES THE SAMPLE CONFIGURATIONS',
     1      ' TO BE DONE.'                                        //
     1      '    "1" CAUSES PLUS OR MINUS ONE THROUGH SIX TO BE'   /
     1      '        DONE FOR EACH TEMPERATURE POINT.'             /
     1      '    "2" CAUSES PLUS OR MINUS ONE, TWO, AND FIVE TO'   /
     1      '        BE DONE AT ODD TEMPERATURE POINTS AND PLUS OR' /
     1      '        MINUS THREE, FOUR, AND SIX TO BE DONE AT EVEN'  /
     1      '        TEMPERATURE POINTS.'                          /
     1      '    "3" CAUSES SAMPLE CONFIGUATIONS SEVEN AND EIGHT'  /
     1      '        TO BE DONE.'                                  /)
 50   CONTINUE
      WRITE(7,1130)
 1130 FORMAT( /,' ENTER THE EXPERIMENT TYPE    ',$)
      READ(5,*) ETYPE
      WRITE(1,*) ETYPE
C  CHECK FOR ERROR
      IF(ETYPE.NE.1.AND.ETYPE.NE.2.AND.ETYPE.NE.3)GO TO 920
C
C     NOW READ THE APPLIED VOLTAGE VALUES.
C
      ASSIGN 530 TO ERRET
 530  CONTINUE
      WRITE(7,1135)
 1135 FORMAT( /,' THE APPLIED VOLTAGES ARE IN VOLTS')
      WRITE(7,1140)
 1140 FORMAT( /,' YOU MAY ENTER UP TO 6 PAIRS OF TEMPERATURES,APPLIED
     1 VOLTAGES',/,' THESE PAIRS WILL BE THE TEMPERATURES
     1AT WHICH',/,' THE APPLIED VOLTAGES WILL CHANGE TO
     1 THE SPECIFIED VALUE')
      WRITE(7,1150)
 1150 FORMAT( /,' ENTER THE NUMBER OF TEMPERATURES,APPLIED VOLTAGES
     1 PAIRS   ',$)
      READ(5,*) NAVOLT
      WRITE(1,*) NAVOLT
      DO 100 I=1,NAVOLT
          WRITE(7,1160)
 1160     FORMAT( /,' ENTER THE TEMPERATURE,APPLIED VOLTAGE PAIRS',/,
     1    ' IN ASCENDING SEQUENTIAL ORDER BY TEMPERATURE VALUES     ')
          READ(5,*) AVLT(1,NAVOLT-I+1),AVLT(2,NAVOLT-I+1)
          WRITE(1,*) AVLT(1,NAVOLT-I+1),AVLT(2,NAVOLT-I+1)
 100  CONTINUE
C
C
C
C
C     NOW GET FIELD VALUES
C
C
      WRITE(7,1220)
 1220 FORMAT( /,' ENTER DESIRED FIELD MAGNITUDE IN KGAUSS   ')
      READ(5,*) FIELD
      WRITE(1,*) FIELD
 20   CONTINUE
```

```
      CLOSE(UNIT=1)
C
C
      GO TO 999
C  ERROR MESSAGES TO FOLLOW
C
C  ERROR FOR TYPE OF TEMPERATURE INCORRECT
C
900   CONTINUE
      WRITE(7,9000)
9000  FORMAT(// VALUE MUST BE "0" OR "1"/)
      GO TO ERRET
C
C  ERROR FOR INCORRECT NUMBER OF TEMPERATURES
C
910   CONTINUE
      WRITE(7,9010)
9010  FORMAT(// VALUE MUST BE GREATER THAN ZERO AND LESS
    1          THAN 100/)
      GO TO ERRET
C  ERROR FOR EXPERIMENT TYPE
920   CONTINUE
      WRITE(7,9020)
9020  FORMAT(// ALLOWED VALUES ARE "1","2",OR "3"/)
      GO TO ERRET
C  ERROR FOR NUMBER OF APPLIED VOLTAGE PAIRS
930   CONTINUE
      WRITE(7,9030)
9030  FORMAT(// VALUE MUST BE AN INTEGER BETWEEN "1" AND "6"/)
      GO TO ERRET
999   CONTINUE
      RETURN
      END
```

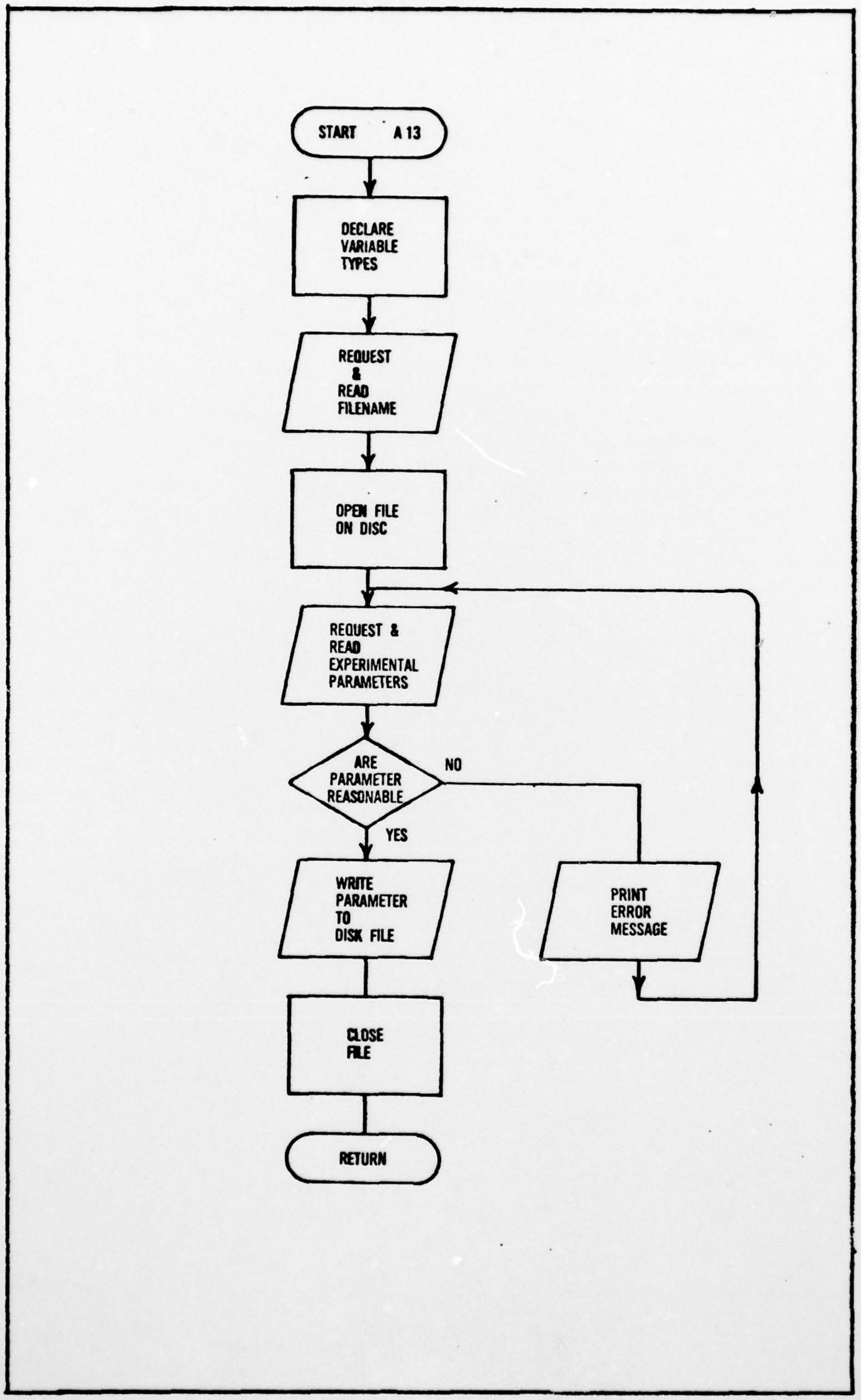

Figure 22. Flow Chart for Module A13

```
0001        SUBROUTINE A13
      C
      C THIS PROGRAM IS TO CREATE THE TEMPERATURE CALIBRATION FILES
      C
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C
      C A13-CREATE THERMOMETER CALIBRATION FILES
      C
      C     THIS MODULE WILL INTERACTIVELY GUIDE THE EXPERIMENTOR
      C TO CREATE A THERMOMETER CALIBRATION FILE ON THE DISK.
      C HE WILL FIRST BE REQUESTED TO ENTER THE FILE NAME.  THE FILE
      C CAN BE STORED ON EITHER DX0: OR DX1:.  DX0 IS PREFERRED IF THERE
      C IS ROOM SO THAT DX1: IS LEFT FREE FOR ONLY THE OUTPUT DATA AND THUS
      C CAN BE READILY REPLACED WITHOUT COPYING FILES.  A THERMOMETER
      C CALIBRATION FILE WOULD NORMALLY BE USED FOR THE LIFE OF THE
      C THERMOMETER.  THE NAME FORMAT IS DX0:THERMO.RED.  THE THERMOMETER
      C IDENTIFIER CAN BE ENTERED NEXT(UP TO 19 CHARACTERS).  THEN THE
      C NUMBER OF CALIBRATION POINTS TO BE USED(UP TO 100) IS ENTERED.
      C THE CALIBRATION POINTS ARE ENTERED NEXT IN THE FORMAT,
      C        TEMPERATURE, VOLTAGE.
      C EACH PAIR IS ENTERED INDIVIDUALLY TO ASSURE MINIMUM ERRORS.
      C THE FILE IS WRITTEN ON DISK IN THE SAME FORMAT AS IT WAS ENTERED
      C ON THE TERMINAL.  ALL INPUT/OUTPUT IS FORMAT FREE.
      C
      C                          AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
      C
      C
      C
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C
      C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
      C
      C HEADER
0002        BYTE TITLE(20),TODAY(9)
0003        REAL ITEMP(100)
0004        INTEGER TYPTEM
0005        BYTE ERRFLG
      C TCALIB
0006        BYTE THRMID(20)
0007        INTEGER NTEMP
0008        REAL TEMCAL(2,100)
      C FILEIN
0009        BYTE TNAME(20),DPNAME(20)
      C
      C RELTIM
0010        INTEGER RTDATA
      C
      C
      C
      C THESE ARE THE COMMON BLOCKS FROM MODULE A1
      C
0011        COMMON /HEADER/TITLE,ITEMP,TYPTEM,TODAY
0012        COMMON /TCALIB/THRMID,NTEMP,TEMCAL
```

```
CC
C
C
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      WRITE(7,1000)
1000  FORMAT( ' ENTER THE FILE NAME IN FORMAT  DX1:THERMO.RED  ',$)
      CALL GETSTR(5,TNAME,19,ERRFLG)
C
      OPEN(UNIT=1,NAME=TNAME,TYPE='NEW')
C
C WRITE THE DATE TO THE TEMPEATURE FILE
C
      WRITE(1,1900) TODAY
1900  FORMAT( 9A1)
C
C
C
C  NOW GET THE THERMOMETER IDENTIFIER
C
      WRITE(7,1010)
1010  FORMAT( /,' ENTER THE THERMOMETER ID IN 19 CHARACTERS   ',$)
      CALL GETSTR(5,THRMID,19,ERRFLG)
      WRITE(1,2000) THRMID
2000  FORMAT( 80A1)
C
C  NOW GET THE NUMBER OF CALIBRATION POINTS TO BE USED
C
      WRITE(7,1020)
1020  FORMAT( /,' ENTER THE NUMBER OF CALIBRATION POINTS
     1TO BE USED',/,' MUST BE LESS THAN 100  ',$)
      READ(5,*) NTEMP
      WRITE(1,*) NTEMP
C
C GET THE CALIBRATION TABLE
C
C
      WRITE(7,1040)
1040  FORMAT( /,' TEMPERATURES ARE TO BE ENTERED SEQUENTIALLY
     1',/,' BEGINNING WITH THE LOWEST   ')
      DO 10 I=1,NTEMP
          WRITE(7,1030)
1030      FORMAT( /,' ENTER THE PAIRS OF TEMPERATURES,
     1VOLTAGES   ',$)
          READ(5,*) TEMCAL(1,I),TEMCAL(2,I)
          WRITE(1,*) TEMCAL(1,I),TEMCAL(2,I)
10    CONTINUE
      GOTO 20
20    CONTINUE
      CLOSE(UNIT=1)
      RETURN
```

```
0040        END
```

AD-A080 175 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOO--ETC F/G 9/2
AUTOMATED HALL EFFECT EXPERIMENT DATA ACQUISITION SYSTEM (AHEED--ETC(U)
DEC 79 E A VERCHOT
UNCLASSIFIED AFIT/GEO/EE/79D-5 NL

2 OF 3
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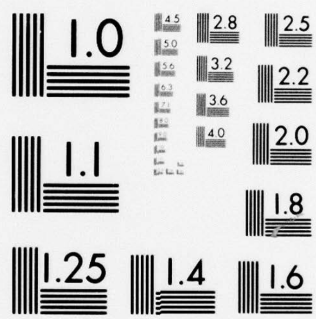
A080175



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

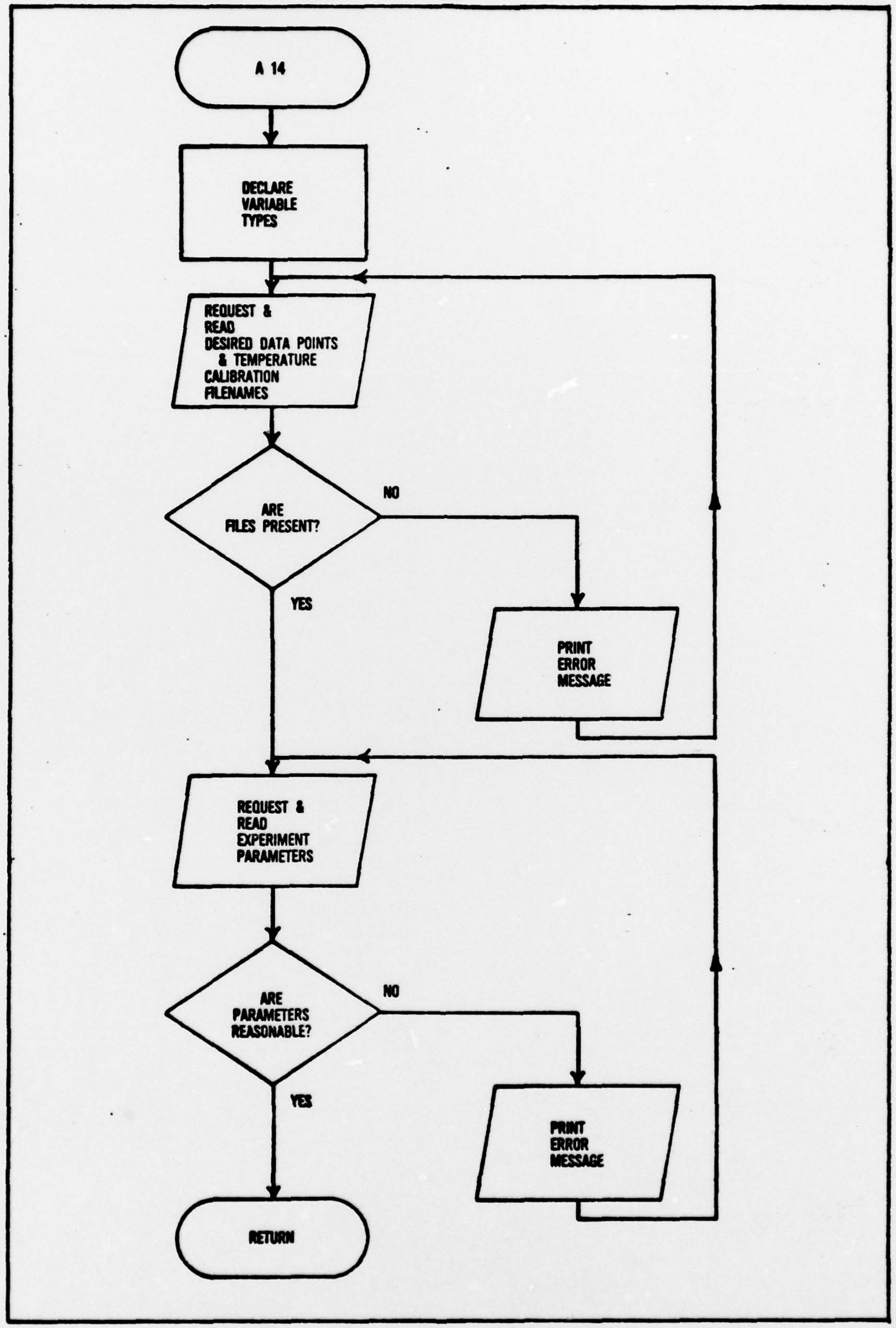


Figure 23. Flow Chart for Module A14

```
0001      SUBROUTINE A14
     C
     CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
     C
     C
     C     A14- OPERATOR INITIALIZATION DIALOGUE
     C
     C
     C      THIS MODULE GUIDES THE EXPERIMENTOR TO ENTER ALL THE
     C PARAMETERS THAT WILL BE NEEDED TO RUN AN EXPERIMENT.  FIRST
     C HE MUST ENTER THE THERMOMETER CALIBRATION FILENAME AND THE
     C DISIRED DATA POINTS FILENAME.  NEXT THE SAMPLE IDENTIFIER IS
     C ENTERED.  NEXT SAMPLE TYPE, VAN DER PAUW OR HALL BAR IS REQUESTED.
     C SAMPLE DIMENSION(S),IN CENTIMETERS, ARE THEN REQUESTED:
     C     THICKNESS, IF THE SAMPLE IF VAN DER PAUW,
     C     THICKNESS, LENGTH AND WIDTH IF THE SAMPLE IS A HALL BAR.
     C     NEXT THE EXPERIMENTOR SPECIFIES WHETHER HE WANTS THE
     C DATA PLOTTED IN REAL TIME OR NOT.  IF HE DOES HE CAN SELECT
     C UP TO FOUR DATA PAIRS TO BE PLOTTED.  THESE PAIRS ARE THEN
     C ENTERED ACCORDING TO THE PROVIDED SYMBOL TABLE.
     C     IF REAL TIME DATA PRINTOUT ON THE TERMINAL IS DESIRED THIS FLAG
     C IS NOW ENTERED.  IF ANY OF THE COMPUTER CONTROLLED EXPERIMENTAL
     C EQUIPMENT IS INOPERATIVE, THIS STATUS IF ENTERED.  THE
     C COMPUTER WILL REQUEST THE OPERATOR TO SET THE PARTICUALAR PIECE(S)
     C OF APPARATUS TO THE REQUIRED VALUE(S) OR INPUT THE DATA POINT(S)
     C REQUIRED FROM THE TERMINAL.  A TABLE IS PROVIDED FOR
     C EQUIPMENT INOPERATIVE FLAGS.  THESE PARAMETERS ARE PASSED TO MODULE
     C A14 VIA A1.
     CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
     C
     C
     C     DATA THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
     C
     C TCALIB
0002      BYTE THRMID(20)
0003      INTEGER NTEMP
0004      REAL TEMCAL(2,100)
     C SAMPLE
0005      BYTE SAMID(20)
0006      INTEGER SAMTYP
0007      REAL SAMT,SAMW,SAML
     C PLTOUT
0008      BYTE POPTS(6,11)
0009      INTEGER PLOTAB(4),PLOTOR(4),PLOT,NP
     C FILEIN
0010      BYTE TNAME(20),DPNAME(20)
     C EQPOUT
0011      BYTE EQUIPF(10,8)
0012      INTEGER IEIOF,EOFLAG(7)
     C
     C RELTIM
0013      INTEGER RTDATA
     C
```

```
      C
      C
      C     INTERNAL DATA SPECIFICATIONS
      C
0014        BYTE LINE(20),COMMA(2)
0015        INTEGER ERRFLG,ERRET,EFLAG(7)
      C THESE ARE THE COMMON BLOCKS FROM MODULE A1
      C
0016        COMMON /TCALIB/THRMID,NTEMP,TEMCAL
      CC
      C
0017        COMMON /SAMPLE/SAMID,SAMTYP,SAMT,SAMW,SAML
0018        COMMON /PLTOUT/PLOT,POPTS,NP,PLOTAB,PLOTOR
0019        COMMON /FILEIN/TNAME,DPNAME
0020        COMMON /EQPOUT/EOFLAG,EQUIPF,IEIOF
0021        COMMON /RELTIM/RTDATA
      C
0022        DATA POPTS/'T','E','M','P',' ',' ',
           2'1','/','T',' ',' ',' ',
           3'R','H','O',' ',' ',' ',
           4'M','U',' ',' ',' ',' ',
           5'P',' ',' ',' ',' ',' ',
           6'D','E','L','T','A',' ',
           7'R','1','/','R','2',' ',
           8'R','3','/','R','4',' ',
           9'R','H',' ',' ',' ',' ',
           1'A','R','1','/','R','2',
           10,0,0,0,0,0/
0023        DATA COMMA/',',0/
      C
      C
      C
      C
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C
      C
      C  NOW GET THE THERMOMETER CALIBRATION FILENAME
      C
      C
0024        ASSIGN 10 TO ERRET
0025  10    CONTINUE
0026        WRITE(7,1000)
0027  1000  FORMAT( ' ENTER THE THERMOMETER CALIBRATION FILENAME   ',$)
0028        CALL GETSTR(5,TNAME,19,ERRFLG)
      C
      C
      C  CHECK TO SEE IF TNAME IS A GOOD FILE
      C
0029        OPEN(UNIT=1,NAME=TNAME,TYPE='OLD',READONLY,ERR=810)
0030        CLOSE(UNIT=1)
      C
      C
      C  GET DESIRED DATA POINTS FILENAME
```

```
C
C
          ASSIGN 20 TO ERRET
20        CONTINUE
          WRITE(7,1010)
1010      FORMAT( ' ENTER DESIRED DATA POINTS FILENAME    ',$)
          CALL GETSTR(5,DPNAME,19,ERRFLG)
C
C
C  NOW CHECK TO SEE IF FILE EXISTS
C
C
          OPEN(UNIT=2,NAME=DPNAME,TYPE='OLD',READONLY,ERR=810)
          CLOSE(UNIT=2)
C
C
C  NOW GET THE SAMPLE ID
C
C
          WRITE(7,1020)
1020      FORMAT( /,' ENTER THE SAMPLE IDENTIFIER  ',$)
          CALL GETSTR(5,SAMID,19,ERRFLG)
C
C
C  GET SAMPLE TYPE
CC
C
          ASSIGN 30 TO ERRET
30        CONTINUE
          WRITE(7,1030)
1030      FORMAT( /,' ENTER A "0" IF THE SAMPLE IS VAN DER PAUW' /
     1              ' ENTER A "1" IF THE SAMPLE IS A HALL BAR' /
     2              ' ENTER THE SAMPLE TYPE   ',$)
          READ(5,*) SAMTYP
          IF(SAMTYP.NE.0.AND.SAMTYP.NE.1) GOTO 830
C
C GET THE SAMPLE DIMENSIONS
C
C
          WRITE(7,1040)
1040      FORMAT( /,' ENTER THE SAMPLE THICKNESS IN CENTIMETERS   ',$)
          READ(5,*) SAMT
C
C
          IF(SAMTYP.EQ.0)GOTO 40
C
C
          WRITE(7,1050)
1050      FORMAT( /,' ENTER THE SAMPLE LENGTH IN CENTIMETERS   ',$)
          READ(5,*) SAML
C
C
          WRITE(7,1060)
```

```
1060  FORMAT( /,' ENTER THE SAMPLE WIDTH IN CENTIMETERS   ',$)
      READ(5,*) SAMW
C
40    CONTINUE
C
C
C SET THE PLOT FLAG
C
C
      WRITE(7,1070)
1070  FORMAT( /,' DO YOU WANT ANY DATA PLOTTED IN REALTIME?' /
     1         ' ENTER A "0" FOR NO OR A "1" FOR YES   ',$)
      READ(5,*) PLOT
C
      IF(PLOT.EQ.0)GOTO 50
C
C GET THE PARAMETERS TO BE PLOTTED
C
C
      ASSIGN 45 TO ERRET
45    CONTINUE
      WRITE(7,1080)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
1080  FORMAT( /,' YOU CAN PLOT UP TO FOUR DATA PAIRS IN REAL TIME.' /
     1         ' THE OPTIONS ARE:' /
     1         ' TEMPERATURE = TEMP ' /
     1         ' R1/R2 = R1/R2  ' /
     1         ' R3/R4 = R3/R4  ' /
     1         ' AVERAGE R1/R2= AR1/R2  ' /
     1         ' INVERSE TEMPERATURE = 1/T' /
     1         ' DELTA TEMPERATURE = DELTA' /
     1         ' RESISTIVITY = RHO' /
     1         ' MOBILITY = MU' /
     1         ' CARRIER CONCENTRATION = P' /
     1         ' HALL COEFFICIENT = RH' //
     1         ' ENTER THE NUMBER OF DATA PAIRS DESIRED ',$)
C
      READ(5,*) NP
C
      IF(NP.LT.0.OR.NP.GT.4) GOTO 840
C
C
C NOW GET THE PLOT PARAMETERS
C
C
      DO 60 K=1,NP
80      CONTINUE
          WRITE(7,1100)
1100      FORMAT( /,' ENTER THE DATA PAIR IN FORMAT  ABCISSA,ORDINATE')
          CALL GETSTR(5,LINE,19,ERRFLG)
          I=INDEX(LINE,COMMA)
          IF(I.LE.1) GO TO 850
          LINE(I)=0
```

```
              J=I+1
              CALL STRPAD(LINE(J),6,ERRFLG)
              IORD1=INDEX(POPTS,LINE(J))
              CALL STRPAD(LINE(1),6,ERRFLG)
              IABC1=INDEX(POPTS,LINE(1))
C
              IF(IABC1.LT.1) GO TO 850
              IF(IORD1.LT.1) GO TO 850
C
              PLOTAB(K)=(IABC1+5)/6
              PLOTOR(K)=(IORD1+5)/6
              GOTO 60
850         CONTINUE
              WRITE(7,8050)
8050          FORMAT( /,' INVALID DATA PAIR ENTERED')
              GO TO 80
C
60      CONTINUE
50      CONTINUE
C
C
C SET THE REAL TIME DATA ON/OFF FLAG
C
C
        WRITE(7,1130)
1130    FORMAT( /,' ENTER A  "1" IF YOU WANT REAL TIME DATA PRINTOUT'
       1,/,' ENTER A  "0" IF NOT    ',$)
        READ(5,*) RTDATA
C
C
C  SET THE EQUIPMENT INOPERATIVE FLAGS
C
C
        WRITE(7,1150)
1150    FORMAT( /,' DO YOU NEED TO SET ANY EQUIPMENT INOPERATIVE
       1 FLAGS?',/,' ENTER "1" FOR YES OR A "0" FOR NO    ',$)
        READ(5,*) IEIOF
C
        IF(IEIOF.NE.1) GOTO 70
C
        WRITE(7,1160)
1160    FORMAT( /,' HOW MANY EQUIPMENT OUT FLAGS WILL YOU SET? ',$)
        READ(5,*) NFLAG
C
C
        WRITE(7,1170)
1170    FORMAT( /,' DMM OUT = "1"' /
       2         ' DVM OUT = "2"' /
       3         ' HEATER POWER SUPPLY OUT = "3"' /
       4         ' BIAS VOLTAGE POWER SUPPLY = "4"' /
       5         ' MAGNET CONTROLLER OUT ="5"' /
       6         ' TEST CONTROLLER OUT = "6"' /
       7         ' GAUSSMETER OUT = "7"')
```

```
      WRITE(7,1180)
1180  FORMAT( /,' ENTER THE FLAGS SEPARATED BY COMMAS  ',$)
      READ(5,*) (EFLAG(I),I=1,NFLAG)
C
C INITIALIZE FLAGS
C
      DO 100 I=1,7
          EOFLAG(I)=0
100   CONTINUE
C
C SET FLAGS
C
      DO 90 I=1,NFLAG
          EOFLAG(EFLAG(I))=1
90    CONTINUE
70    CONTINUE
C
      GO TO 1
C
C   ERROR MESSAGES
C
C
C
C  ERROR FOR INPUT FILE DOES NOT EXIST
C
C
810   CONTINUE
      WRITE(7,8010)
8010  FORMAT( /,' FILENAME DOES NOT EXIST ON SYSTEM')
      GO TO ERRET
C
C
C
C ERROR FOR SAMPLE TYPE ILLEGAL
C
C
830   CONTINUE
      WRITE(7,8030)
8030  FORMAT( /,' SAMPLE TYPE MUST BE EITHER A "0" OR A "1"')
      GO TO ERRET
C
C
C ERROR FOR ILLEGAL NUMBER OF PLOT PAIRS ENTERED
C
C
840   CONTINUE
      WRITE(7,8040)
8040  FORMAT( /,' NUMBER OF PAIRS CAN ONLY BE 1,2,3,OR 4')
      GO TO ERRET
C
1     CONTINUE
      RETURN
      END
```

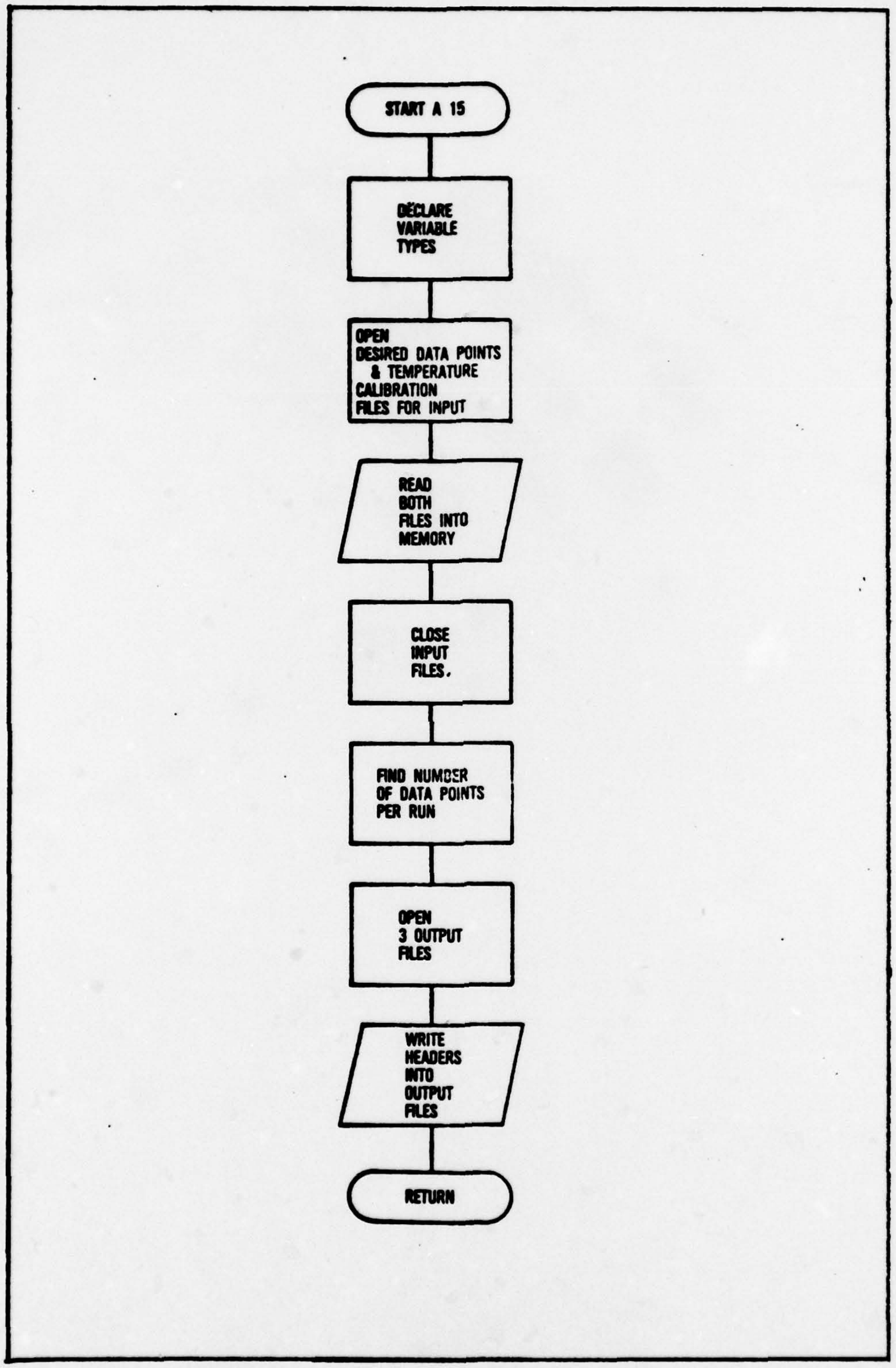


Figure 24. Flow Chart for Module A15

```
0001      SUBROUTINE A15
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A15--SETUP  FILES AND PARAMETERS
C
C
C     THIS MODULE  OPENS THE DESIRED DATA
C POINTS FILE AND THE THERMOMETER CALIBRATION FILE AND ENTERS THE
C NEEDED DATA FROM THESE INTO THE APPROPRIATE ARRAYS IN THE PROGRAM.
C IT THEN OPENS THE DISK FILES NEEDED FOR DATA OUTPUT AND INITIALIZES THEM.
C PRIOR TO PROGRAM EXECUTION ANY FILES FROM PREVIOUS EXPERIMENTS
C SHOULD BE RENAMED USING THE MONITOR COMMAND,
C           RENAM FILESPEC: FILESPEC:
C BECAUSE THE PROGRAM WILL DESTROY THEM WHEN THE NEW OUTPUT FILES ARE
C CREATED.  THE PROGRAM PAUSES WHEN A14 IS FINISHED UNTIL THE USER
C GIVES THE COMMAND TO BEGIN THE EXPERIMENT.  HE SHOULD DO THIS
C ONLY WHEN HE IS CERTAIN THAT HE HAS TURNED ON AND INITIALIZED ALL
C REQUIRED EQUIPMENT FOR THE EXPERIMENT.
C
C                 AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
0002      BYTE ERRFLG
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C
C HEADER
0003      BYTE TITLE(20),TODAY(9)
0004      REAL ITEMP(100)
0005      INTEGER TYPTEM
C DATAIN
0006      REAL TEMP(100),FIELD,AVLT(2,6)
0007      INTEGER NTEMPT,ETYPE,NAVOLT,NDATPT
C TCALIB
0008      BYTE THRMID(20)
0009      INTEGER NTEMP
0010      REAL TEMCAL(2,100)
C SAMPLE
0011      BYTE SAMID(20)
0012      INTEGER SAMTYP
0013      REAL SAMT,SAMW,SAML
C PLTOUT
0014      BYTE POPTS(6,10)
0015      INTEGER PLOTAB(4),PLOTOR(4),PLOT,NP
C FILEIN
0016      BYTE TNAME(20),DPNAME(20)
C EQPOUT
0017      BYTE EQUIPF(10,8)
0018      INTEGER IEIOF,EOFLAG(7)
C CONTRL
0019      INTEGER ABORT
C
C RELTIM
```

```
      INTEGER RTDATA
C
C
C
C THESE ARE THE COMMON BLOCKS FROM MODULE A1
C
      COMMON /HEADER/TITLE,ITEMP,TYPTEM,TODAY
      COMMON /DATAIN/NTEMPT,TEMP,ETYPE,FIELD,
     2NAVOLT,AVLT,NDATPT
      COMMON /TCALIB/THRMID,NTEMP,TEMCAL
CC
C
      COMMON /SAMPLE/SAMID,SAMTYP,SAMT,SAMW,SAML
      COMMON /PLTOUT/PLOT,POPTS,NP,PLOTAB,PLOTOR
      COMMON /FILEIN/TNAME,DPNAME
      COMMON /EQPOUT/EQFLAG,EQUIPF,IEIOF
      COMMON /RELTIM/RTDATA
      COMMON /CONTRL/ABORT
C
C
C  NOW OPEN THE INPUT FILES
C
      OPEN(UNIT=1,NAME=TNAME,TYPE='OLD',READONLY)
      OPEN(UNIT=2,NAME=DPNAME,TYPE='OLD',READONLY)
C
C  NOW READ THE THERMOMETER CALIBRATION FILE INTO MEMORY
C
      CALL GETSTR(1,DATE,19,ERRFLG)
      CALL GETSTR(1,THRMID,19,ERRFLG)
C
C  NOW READ THE CALIBRATION TABLE IN
C
C  TEMCAL(1,I) CONTAINS THE TEMPERATURES AND
      READ(1,*) NTEMP
      DO 10 I=1,NTEMP
         READ(1,*) TEMCAL(1,I),TEMCAL(2,I)
10    CONTINUE
C
      CLOSE(UNIT=1)
C
C   READ THE DESIRED DATA POINTS FILE INTO MEMORY
C
      CALL GETSTR(2,DATE,19,ERRFLG)
      CALL GETSTR(2,TITLE,19,ERRFLG)
      READ(2,*) TYPTEM
      READ(2,*) NTEMPT
C
C  TEST TO DETERMINE WHETHER TEMPERATURE OR INVERSE
C  TEMPERATURE IS TO BE USED IN THE EXPERIMENT.
C  THEN GET THE TEMPERATURE POINTS.
C
C
      IF(TYPTEM.NE.0) GO TO 20
```

```
C
C  READ TEMPERATURE POINTS AND CALCULATE INVERSE TEMPERTURES
C
           READ(2,*) (TEMP(I),I=1,NTEMPT)
             DO 30 I=1,NTEMPT
                 ITEMP(I)=1000/TEMP(I)
30           CONTINUE
           GO TO 100
C
C  READ THE INVERSE TEMPERATURES AND CALCULATE THE TEMPERATURES.
C
20           CONTINUE
           READ(2,*) (ITEMP(I),I=1,NTEMPT)
                DO 40 I=1,NTEMPT
                   TEMP(I)=1000/ITEMP(I)
40              CONTINUE
100        CONTINUE
C
C  GET THE EXPERIMENT TYPE
C
           READ(2,*) ETYPE
C
C NOW FIND OUT HOW MANY DATA POINTS THERE ARE
           IF(ETYPE.EQ.1)NDATPT=20
           IF(ETYPE.EQ.2)NDATPT=10
           IF(ETYPE.EQ.3)NDATPT=8
C
C  GET THE NUMBER OF APPLIED VOLTAGE CHANGE POINTS
C
           READ(2,*) NAVOLT
C
C
C  READ THE TEMPERATURE,APPLIED VOLTAGE PAIRS
C
C
           DO 50 I=1,NAVOLT
              READ(2,*) AVLT(1,I),AVLT(2,I)
50         CONTINUE
C
C  GET THE FIELD VALUES
C
C
             READ(2,*) FIELD
C
           CLOSE(UNIT=2)
C
C
C
C  NOW SET UP THE OUTPUT FILE FOR THE DATA
850        CONTINUE
C
C
           OPEN(UNIT=3,NAME='DX1:OUTPUT.DAT',TYPE='NEW',
```

```
         2FORM='UNFORMATTED',INITIALSIZE=8,ERR=800)
          OPEN(UNIT=1,NAME='DX1:RAWOUT.DAT',TYPE='NEW',
         2FORM='UNFORMATTED',INITIALSIZE=100,ERR=800)
          OPEN(UNIT=2,NAME='DX1:INTRMD.DAT',TYPE='NEW',
         2FORM='UNFORMATTED',INITIALSIZE=8,ERR=800)
          GO TO 310
 800      CONTINUE
             WRITE(7,8000)
 8000        FORMAT(' ',' THERE IS NOT ENOUGH ROOM ON DX1: FOR THE
         2   OUTPUT FILES',/,' PLACE A FRESH DISK IN THE DRIVE THEN',/,
         3   ' INPUT AN INTEGER')
          ERRFLG=0
          READ(5,*) INTGER
          GO TO 850
 810         CONTINUE
 C           WRITE THE HEADERS ON THE OUTPUT FILES
             DO 5000 N=1,3
                 WRITE(N) (TODAY(M),M=1,9)
                 WRITE(N) (TITLE(J),J=1,19)
                 WRITE(N) (THRMID(K),K=1,19)
                 WRITE(N) (SAMID(L),L=1,20)
                 WRITE(N) SAMTYP
                 IF(SAMTYP.NE.0) GO TO 5010
                     WRITE(N) SAMT
                     GO TO 5000
 5010            CONTINUE
                     WRITE(N) SAMT,SAMW,SAML
 5000        CONTINUE
 C
          RETURN
          END
```

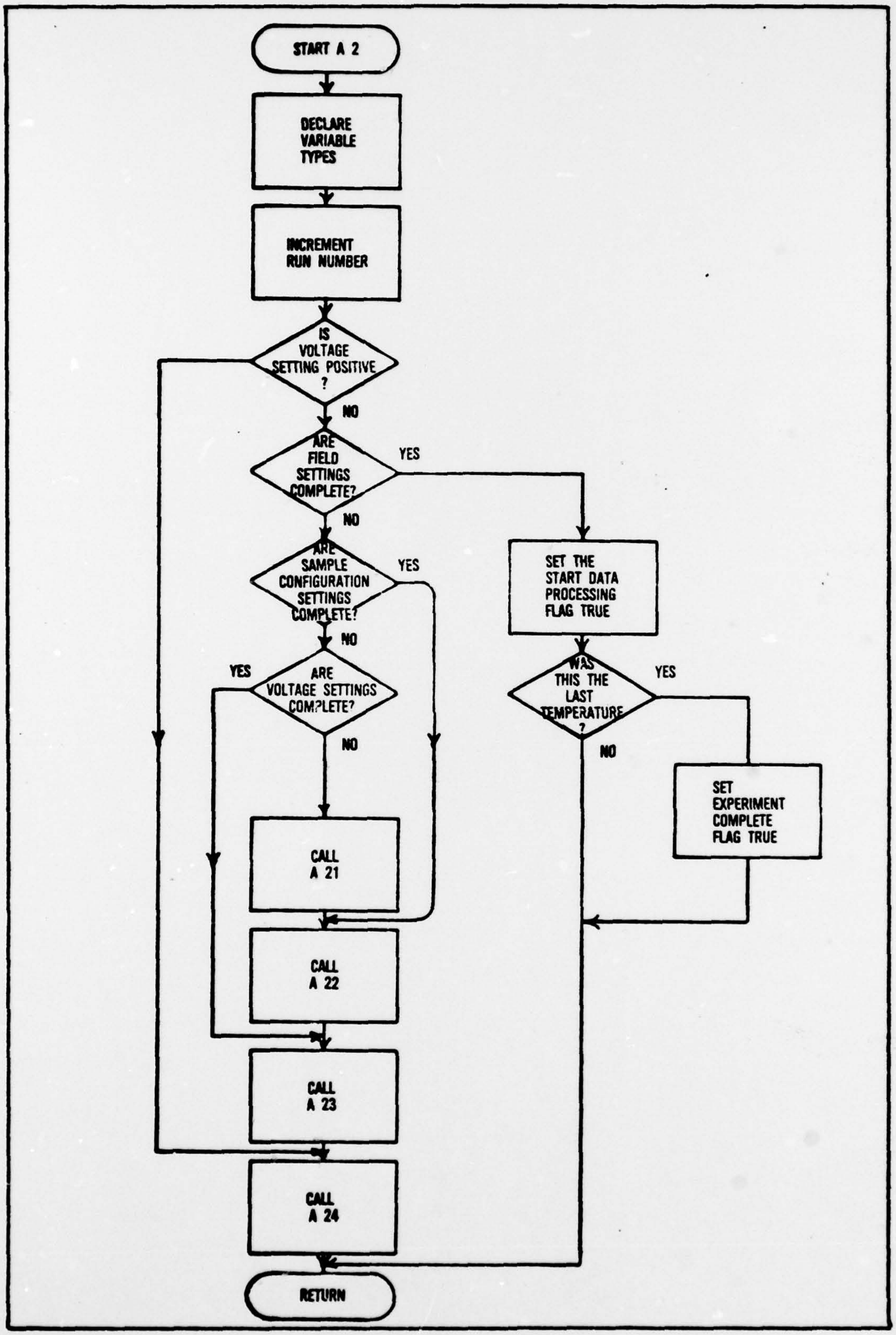


Figure 25. Flow Chart for Module A2

```
      SUBROUTINE A2
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C  MODULE A2---DETERMINE SETTING
C THIS MODULE CONTROLS A21---A24.
C
C  THIS MODULE WILL DETERMINE THE APPROPRIATE
C  SETTINGS FOR ALL OF THE DATA PARAMETERS.
C A2 IS THE EXECUTIVE MODULE. IT CHECKS ALL OF THE CONTROL FLAGS AND
C CALLS THE APPROPRIATE PARAMETER SETTING MODULES.  IT ALSO RESETS
C ALL OF THE CONTROL FLAGS AS APPROPRIATE.
C     FOUR MODULES ARE UNDER THE CONTROL OF A2:
C         A21---DETERMINE TEMPERATURE SETTING
C         A22---DETERMINE FIELD SETTING
C         A23---DETERMINE SAMPLE CONFIGURATION SETTINGS
C         A24---DETERMINE APPLIED VOLTAGE SETTING.
C     AFTER EACH BLOCK OF DATA IS COMPLETE A2 GENERATES A START
C DATA PROCESSING SIGNAL WHICH WILL SIGNAL MODULE A5,
C REDUCE DATA, TO EXECUTE AS SOON AS DATA ACQUISITION COMPLETE IS RECEIVED.
C AT THE APPROPRIATRE TIME, A2 GENERATES THE EXPERIMENT COMPLETE SIGNAL
C TO END THE EXPERIMENTAL RUN.
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C  DATA SPECIFICATIONS
C
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C DATAIN
      REAL TEMP(100),FIELD,AVLT(2,6)
      INTEGER NTEMPT,ETYPE,NAVOLT,NDATPT
C TCALIB
      BYTE THRMID(20)
      INTEGER NTEMP
      REAL TEMCAL(2,100)
C EQPOUT
      BYTE EQUIPF(10,8)
      INTEGER IEIOF,EOFLAG(7)
C     THESE ARE THE DATA SPECIFICATIONS FOR A2
C     CONSIG
      INTEGER SDP,EXPC,FSCOM,SCSCOM,VLTCOM
C
C  A2COM
      INTEGER NTEM,SCSET,SCOUNT,VCOUNT,RUN
      REAL TEMSET,FLDSET,VLTSET,X0
C THESE ARE THE COMMON BLOCKS FROM MODULE A1
      COMMON /DATAIN/NTEMPT,TEMP,ETYPE,FIELD,
     2NAVOLT,AVLT,NDATPT
      COMMON /TCALIB/THRMID,NTEMP,TEMCAL
      COMMON /EQPOUT/EOFLAG,EQUIPF,IEIOF
C THE NAMED COMMON BLOCKS FOR A2CMN FOLLOW.
      COMMON /CONSIG/SDP,EXPC,FSCOM,SCSCOM,VLTCOM
      COMMON /A2COM/TEMSET,FLDSET,VLTSET,X0,NTEM,SCSET,SCOUNT,
     2VCOUNT,RUN
C
```

```
C RESET SCOUNT
C
C
CC TEST THE CONTROL SIGNALS TO DETERMINE WHERE TO GO NEXT
10    CONTINUE
      RUN=RUN+1
C IF THE OLD VOLTAGE SETTING IS POSITIVE GO DO THE NEGATIVE VOLTAGE
C WITH ALL THE OTHER PARAMETERS THE SAME.
      IF(VLTSET.GT.0.0)GO TO 24
C IF ALL FIELD SETTINGS ARE COMPLETE AT THIS TEMPERATURE SET THE CONTROL
C SIGNALS AND GO TO A5:REDUCE DATA.
      IF(FSCOM.EQ.1.AND.SCSET.EQ.5.AND.ETYPE.EQ.1)GO TO 11
      IF(FSCOM.EQ.1)GO TO 100
11    CONTINUE
C IF ALL THE SAMPLE CONFIGURATIONS ARE COMPLETE AT THIS FIELD SETTING
C GO TO A NEW FIELD SETTING.
      IF(SCSCOM.EQ.1)GO TO 22
C IF ALL THE VOLTAGE SETTINGS ARE COMPLETE AT THIS SAMPLE
C CONFIGURATION SET A NEW CONFIGURATION.
      IF(VLTCOM.EQ.1)GO TO 23
      IF(VCOUNT.EQ.1)GO TO 24
C
C  CALL THE TEMPERATURE SETTING MODULE
C
21    CONTINUE
      CALL A21
C
C  CALL THE FIELD SETTING MODULE
C
22    CONTINUE
      SCSCOM=0
      CALL A22
C
C  CALL THE SAMPLE CONFIGURATIONS SETTING MODULE
C
23    CONTINUE
      VLTCOM=0
      CALL A23
C
C  CALL THE APPLIED VOLTAGE SETTING MODULE
C
24    CONTINUE
      CALL A24
      GO TO 900
C  NOW GO TO THE REDUCE DATA MODULE TO REDUCE A BLOCK OF DATA
C
100   CONTINUE
      RUN=RUN - 1
      FSCOM=0
      SDP=1
      IF((NTEM-1).EQ.NTEMPT)EXPC=1
      GO TO 900
C
```

```
C
C
900   CONTINUE
      RETURN
      END
```

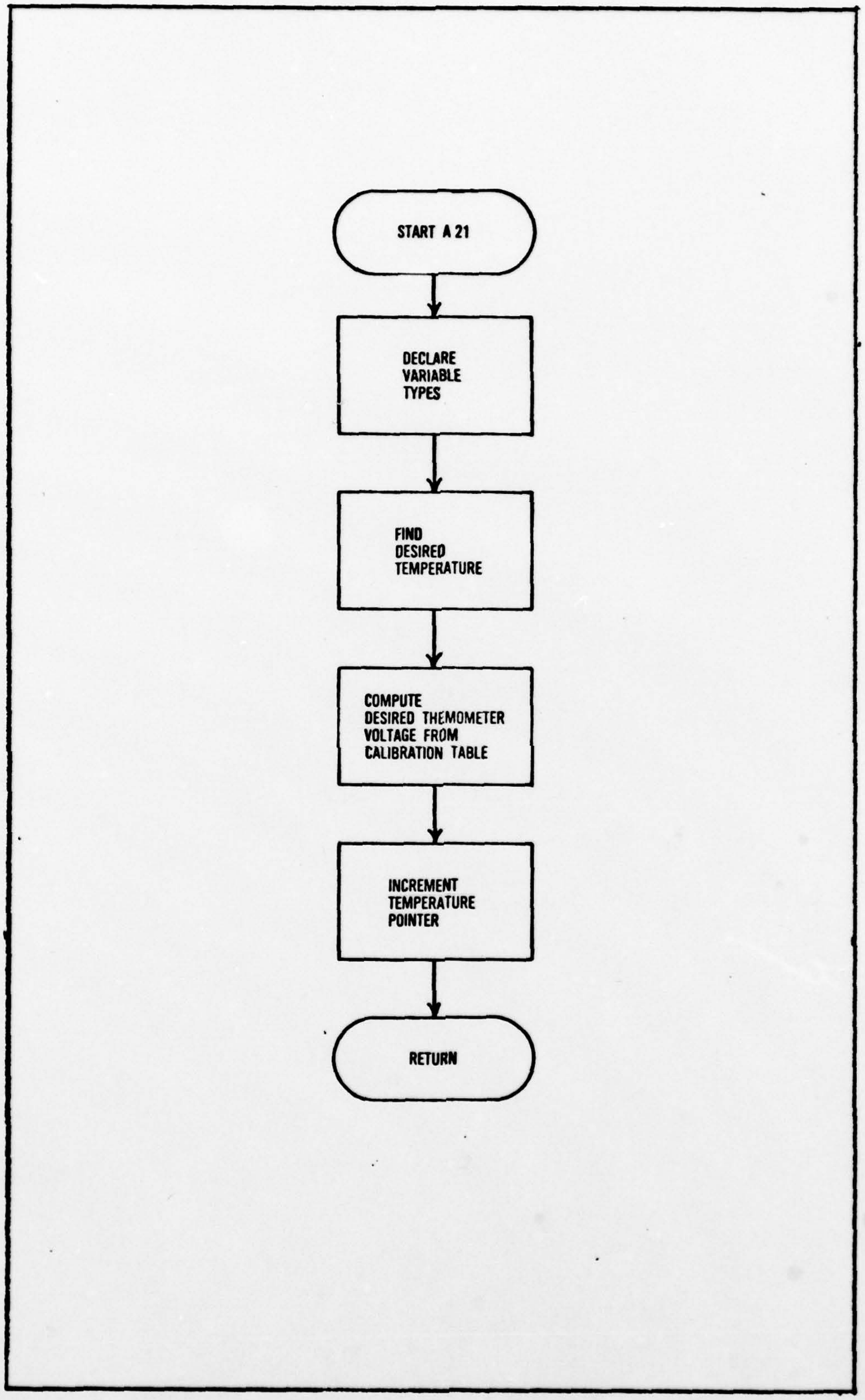


Figure 26. Flow Chart for Module A21

```
      SUBROUTINE A21
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C  MODULE A21---DETERMINE TEMPERATURE SETTNGS
C
C  THIS MODULE DETERMINES THE PROPER TEMPERATURE
C  SETTING FOR THE SAMPLE.  IT TAKES THE DESIRED TEMPERATURE
C  AND CONVERTS IT TO THE VOLTAGE NEEDED AND
C  PASSES THIS VALUE BACK TO A2.
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C DATA SPECIFICATIONS
C
C C
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C DATAIN
      REAL TEMP(100),FIELD,AVLT(2,6)
      INTEGER NTEMPT,ETYPE,NAVOLT,NDATPT
C TCALIB
      BYTE THRMID(20)
      INTEGER NTEMP
      REAL TEMCAL(2,100)
C     THESE ARE THE DATA SPECIFICATIONS FOR A2
C  A2COM
      INTEGER NTEM,SCSET,SCOUNT,VCOUNT,RUN
      REAL TEMSET,FLDSET,VLTSET,X0
C THESE ARE THE COMMON BLOCKS FROM MODULE A1
      COMMON /DATAIN/NTEMPT,TEMP,ETYPE,FIELD,
     2NAVOLT,AVLT,NDATPT
      COMMON /TCALIB/THRMID,NTEMP,TEMCAL
C THE NAMED COMMON BLOCKS FOR A2CMN FOLLOW.
      COMMON /A2COM/TEMSET,FLDSET,VLTSET,X0,NTEM,SCSET,SCOUNT,
     2VCOUNT,RUN
C
C
C  LOCAL VARIABLES
C
      REAL D(100),P(100),Y0
      INTEGER NS,NF
C NOW RESET SETTINGS FOR NEW DATA BLOCK
      DATA FLDSET,SCSET,Y0/0.0,0,0.0/
C
C  NOW COMPUTE THE VOLTAGE ON THE SILICON THERMOMETER
C  THAT IS EQUIVILENT TO THE DESIRED TEMPERATURE
C
      X0=TEMP(NTEM)
      DO 10 I=1,NTEMP
         IF(X0.LE.TEMCAL(1,I))GO TO 20
10    CONTINUE
C
20    NS=I-3
```

```
      IF(NS.LT.1)NS=1
          NF=I+3
      IF(NF.GT.NTEMP)NF=NTEMP
C
C
      Y0=0.0
      DO 30 I=NS,NF
          D(I)=1.0
          P(I)=1.0
          DO 40 J=NS,NF
         IF(I.EQ.J)GO TO 40
              D(I)=D(I)*(TEMCAL(1,I)-TEMCAL(1,J))
              P(I)=P(I)*(X0-TEMCAL(1,J))
40        CONTINUE
          Y0=Y0+(P(I)/D(I))*TEMCAL(2,I)
30    CONTINUE
      NTEM=NTEM+1
      TEMSET=Y0
      RETURN
      END
```

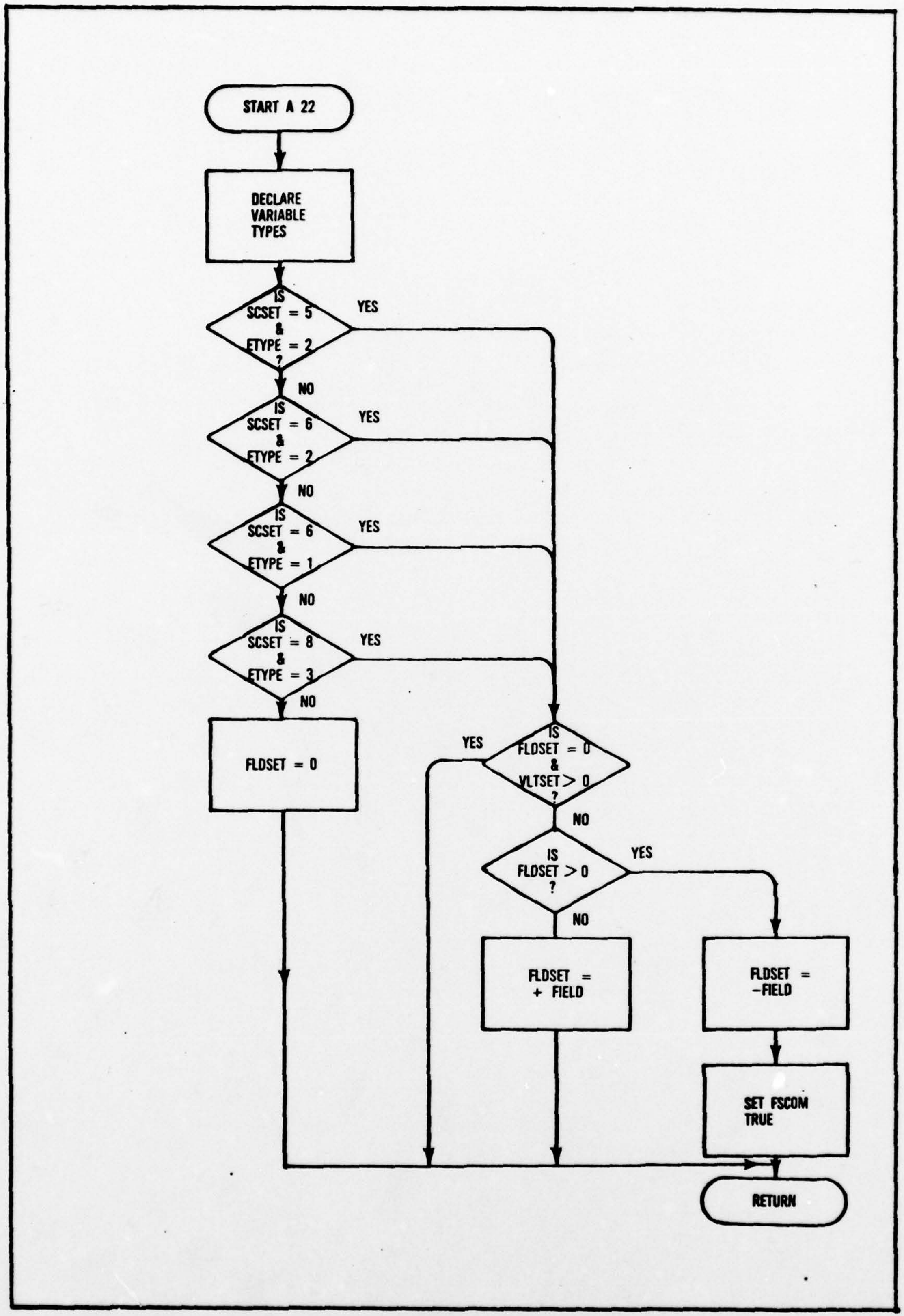


Figure 27. Flow Chart for Module A22

```
      SUBROUTINE A22
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A22---DETERMINE FIELD SETTING
C
C THIS MODULE DETERMINES THE FIELD SETTING.
C FOUR CASES WILL CAUSE THE FIELD TO BE SET:
C    1.  SAMPLE CONFIGURATION=6 AND EXPERIMENT TYPE=1.
C    2.  SAMPLE CONFIGURATION=5 AND EXPERIMENT TYPE =2.
C    3.  SAMPLE CONFIGURATION =6 AND EXPERIMENT TYPE=2.
C    4.  SAMPLE CONFIGURATION =8 AND EXPERIMENT TYPE =3.
C ALL OTHER CASES CAUSE THE FIELD TO BE ZERO.
C IF FIELD IS ALREADY SET POSITIVE AND ONE OF THE ABOVE FOUR CASES
C ARE TRUE, THE POLARITY IS REVERSED.
C
C
C         AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C DATA SPECIFICATIONS
C
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C DATAIN
      INTEGER ETYPE
      REAL TEMP(100),FIELD,AVLT(2,6)
C     THESE ARE THE DATA SPECIFICATIONS FOR A2
C
C     CONSIG
      INTEGER SDP,EXPC,FSCOM,SCSCOM,VLTCOM
C
C  A2COM
      INTEGER NTEM,SCSET,SCOUNT,VCOUNT,RUN
      REAL TEMSET,FLDSET,VLTSET,X0
C THE NAMED COMMON BLOCKS FOR A2CMN FOLLOW.
      COMMON /CONSIG/SDP,EXPC,FSCOM,SCSCOM,VLTCOM
      COMMON /A2COM/TEMSET,FLDSET,VLTSET,X0,NTEM,SCSET,SCOUNT,
     2VCOUNT,RUN
C THESE ARE THE COMMON BLOCKS FROM MODULE A1
      COMMON /DATAIN/NTEMPT,TEMP,ETYPE,FIELD,
     2NAVOLT,AVLT,NDATPT
C
C
C TEST SAMPLE CONFIGURATION SETTING
      IF(SCSET.EQ.5.AND.ETYPE.EQ.2) GO TO 10
      IF(SCSET.EQ.6.AND.ETYPE.EQ.2) GO TO 10
      IF(SCSET.EQ.6.AND.ETYPE.EQ.1) GO TO 10
      IF(SCSET.EQ.8.AND.ETYPE.EQ.3) GO TO 10
      FLDSET=0
      GO TO 900
10    CONTINUE
         IF(FLDSET.EQ.0.0.AND.VLTSET.GT.0.0)GO TO 900
```

```
            IF(FLDSET.GT.0.0) GO TO 100
            FLDSET=FIELD
         GO TO 900
100   CONTINUE
        FLDSET=-FIELD
        FSCOM=1
900   CONTINUE
      RETURN
      END
```

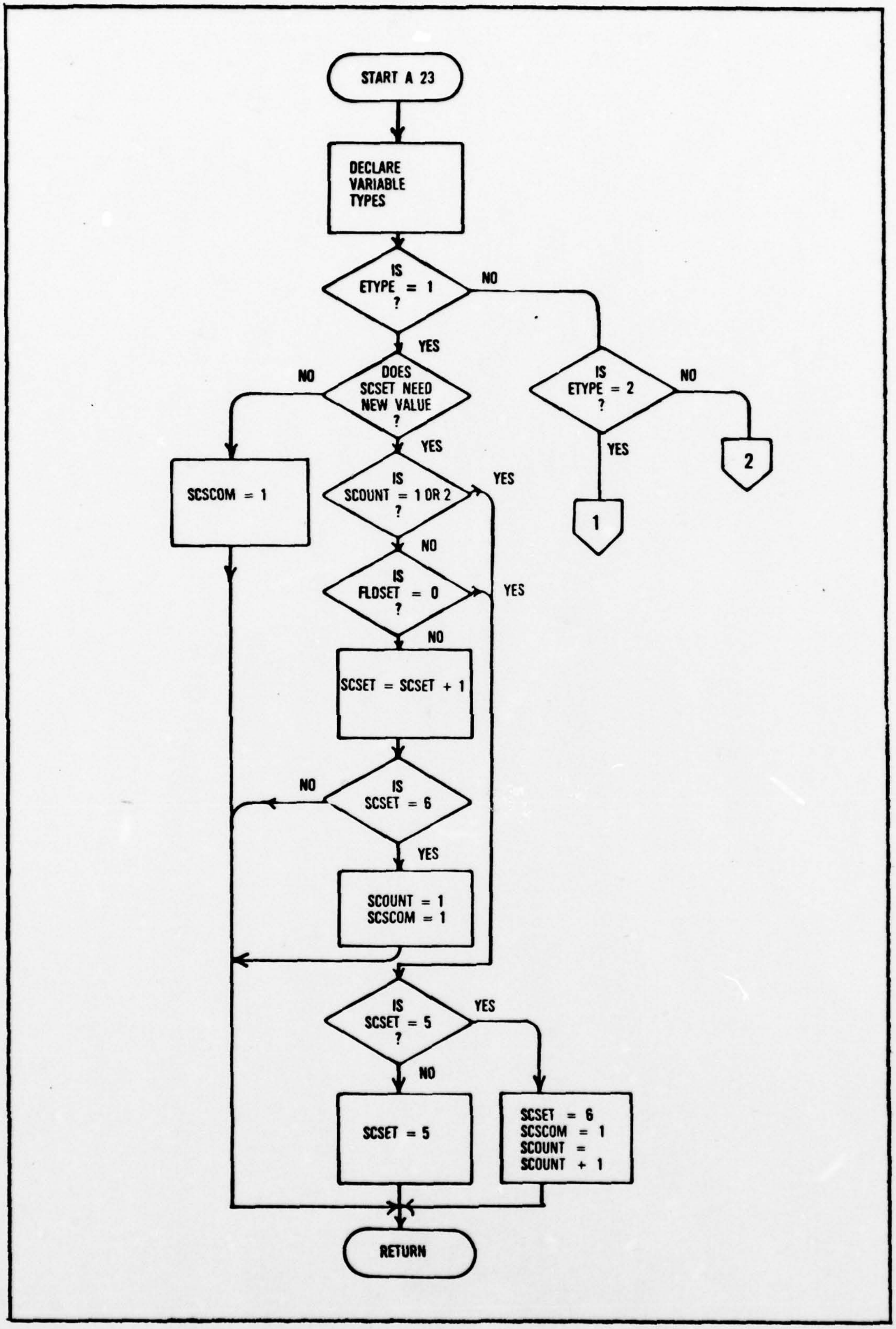


Figure 28. Flow Chart for Module A23

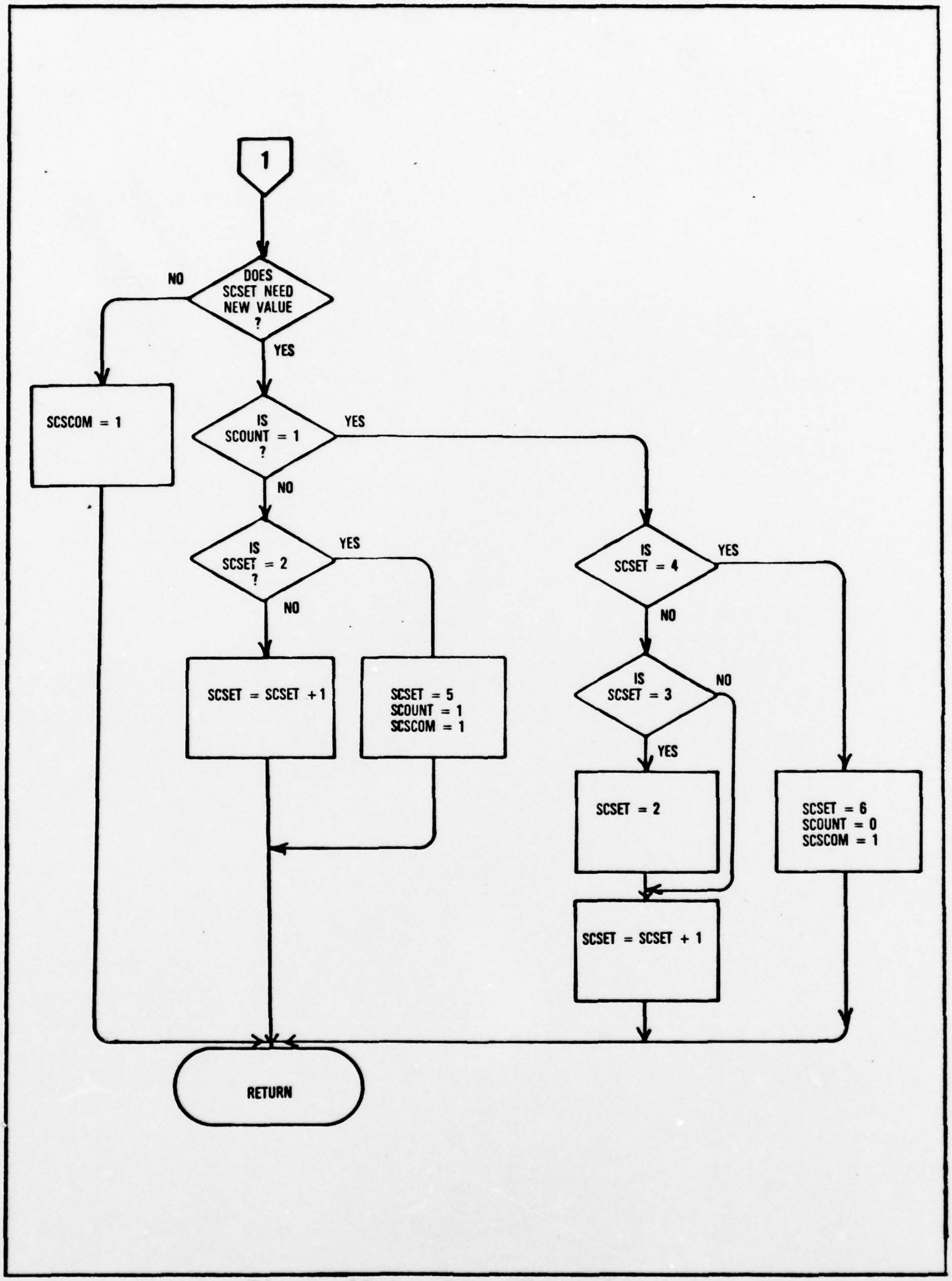


Figure 28-1. Flow Chart for Module A23

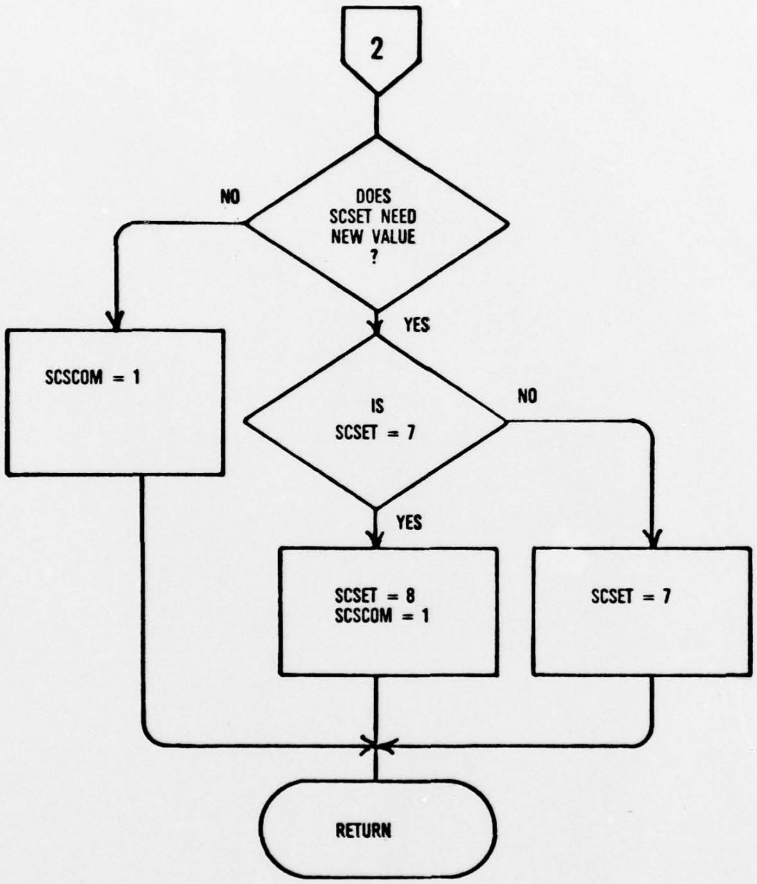


Figure 28-2. Flow Chart for Module A23

```
      SUBROUTINE A23
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A23---DETERMINE SAMPLE CONFIGURATION SETTING
C
C     THIS MODULE WILL DETERMINE THE SAMPLE CONFIGURATION
C SETTING.  THE EXPERIMENT PARAMETER DETERMINES HOW THE SAMPLE
C CONFIGURATIONS WILL BE SET.  THE THREE CHOICES ARE,
C
C     ETYPE=1---SAMPLE CONFIGURATIONS 1,2,3,4,5,6 ARE SET IN TURN.
C
C     ETYPE=2---SAMPLE CONFIGURATIONS 1,2,5 ARE SET FOR THE FIRST AND
C          EACH SUCCEEDING ODD TEMPERATURE.
C            ---SAMPLE CONFIGURATIONS 3,4,6 ARE SET FOR THE SECOND AND
C          EACH SUCCEEDING EVEN TEMPERATURE.
C
CC    ETYPE=3---SAMPLE CONFIGURATIONS 7 AND 8 ARE SET.
C
C WHEN ALL SAMPLE CONFIGURATIONS ARE COMPLETE THE SCSCOM(SAMPLE
C CONFIGURATIONS COMPLETE) SIGNAL IS SET TRUE.
C
C
C          AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C DATA SPECIFICATIONS
C
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C DATAIN
      INTEGER ETYPE
      REAL TEMP(100),FIELD,AVLT(2,6)
C     THESE ARE THE DATA SPECIFICATIONS FOR A2
C
C     CONSIG
      INTEGER SDP,EXPC,FSCOM,SCSCOM,VLTCOM
C
C  A2COM
      INTEGER NTEM,SCSET,SCOUNT,VCOUNT,RUN
      REAL TEMSET,FLDSET,VLTSET,X0
C THE NAMED COMMON BLOCKS FOR A2CMN FOLLOW.
      COMMON /CONSIG/SDP,EXPC,FSCOM,SCSCOM,VLTCOM
      COMMON /A2COM/TEMSET,FLDSET,VLTSET,X0,NTEM,SCSET,SCOUNT,
     2VCOUNT,RUN
C THESE ARE THE COMMON BLOCKS FROM MODULE A1
      COMMON /DATAIN/NTEMPT,TEMP,ETYPE,FIELD,
     2NAVOLT,AVLT,NDATPT
C
C
C
C RESET APPLIED VOLTAGES COMPLETE SIGNAL(VLTCOM)
C
      DATA VLTCOM/0/
```

```
C
C TEST TO FIND THE EXPERIMENT TYPE
C
         IF(ETYPE.NE.1)GO TO 20
C           IF EXPERIMENT TYPE EQUALS 1.
            IF(FLDSET.EQ.0.0.AND.VLTSET.GT.0.0.AND.(SCSET.EQ.5.
        2OR.SCSET.EQ.6)) GO TO 35
            IF(FLDSET.NE.0.0)GO TO 10
               IF(SCOUNT.EQ.1.OR.SCOUNT.EQ.2)GO TO 10
                  SCSET=SCSET+1
                  IF(SCSET.EQ.6)SCOUNT=1
              IF(SCSET.EQ.6)SCSCOM=1
                  GO TO 900
C        NOW DO THE 5 AND 6 CONFIGURATIONS WHEN THE FIELD IS SET
   10          CONTINUE
               IF(SCSET.EQ.5)GO TO 11
                   SCSET=5
                   GO TO 900
   11          CONTINUE
                   SCSET=6
                   SCSCOM=1
                   SCOUNT=SCOUNT+1
                   IF(SCOUNT.GT.2)SCOUNT=2
                   GO TO 900
C        IF ETYPE EQUALS 2
   20    CONTINUE
         IF(ETYPE.NE.2)GO TO 30
            IF(FLDSET.EQ.0.0.AND.VLTSET.GT.0.0.AND.(SCSET.EQ.5.
        2OR.SCSET.EQ.6)) GO TO 35
            IF(FLDSET.NE.0.0)GO TO 35
             IF(SCOUNT.EQ.1)GO TO 32
C               DO THE ODD TEMPERATURE SAMPLE CONFIGURATIONS
                IF(SCSET.EQ.2)GO TO 31
                    SCSET=SCSET+1
                    GO TO 900
   31           CONTINUE
                    SCSET=5
                    SCOUNT=1
                    SCSCOM=1
            GO TO 900
C               DO THE EVEN TEMPERATURE SAMPLE CONFIGURATIONS
   32          CONTINUE
                IF(SCSET.EQ.4)GO TO 33
                    IF(SCSET.NE.3)SCSET=2
                    SCSET=SCSET+1
                    GO TO 900
   33           CONTINUE
                    SCSET=6
                    SCOUNT=0
                    SCSCOM=1
            GO TO 900
   35       CONTINUE
C  SET THE SCSCOM SIGNAL TRUE .
```

```
C THIS WILL ALLOW THE EXECUTION OF THE CONFIGURATION WITH FIELD APPLIED
              SCSCOM=1
              GO TO 900
C     IF ETYPE EQUALS 3
30    CONTINUE
      IF(FLDSET.EQ.0.0.AND.VLTSET.GT.0.0.AND.SCSET.EQ.8) GO TO 35
         IF(FLDSET.NE.0.0)GO TO 40
         IF(SCSET.NE.7)GO TO 47
            SCSET=8
            SCSCOM=1
            GO TO 900
47       CONTINUE
            SCSET=7
            GO TO 900
40       CONTINUE
         SCSCOM=1
         GO TO 900
C
C
900   CONTINUE
      RETURN
      END
```

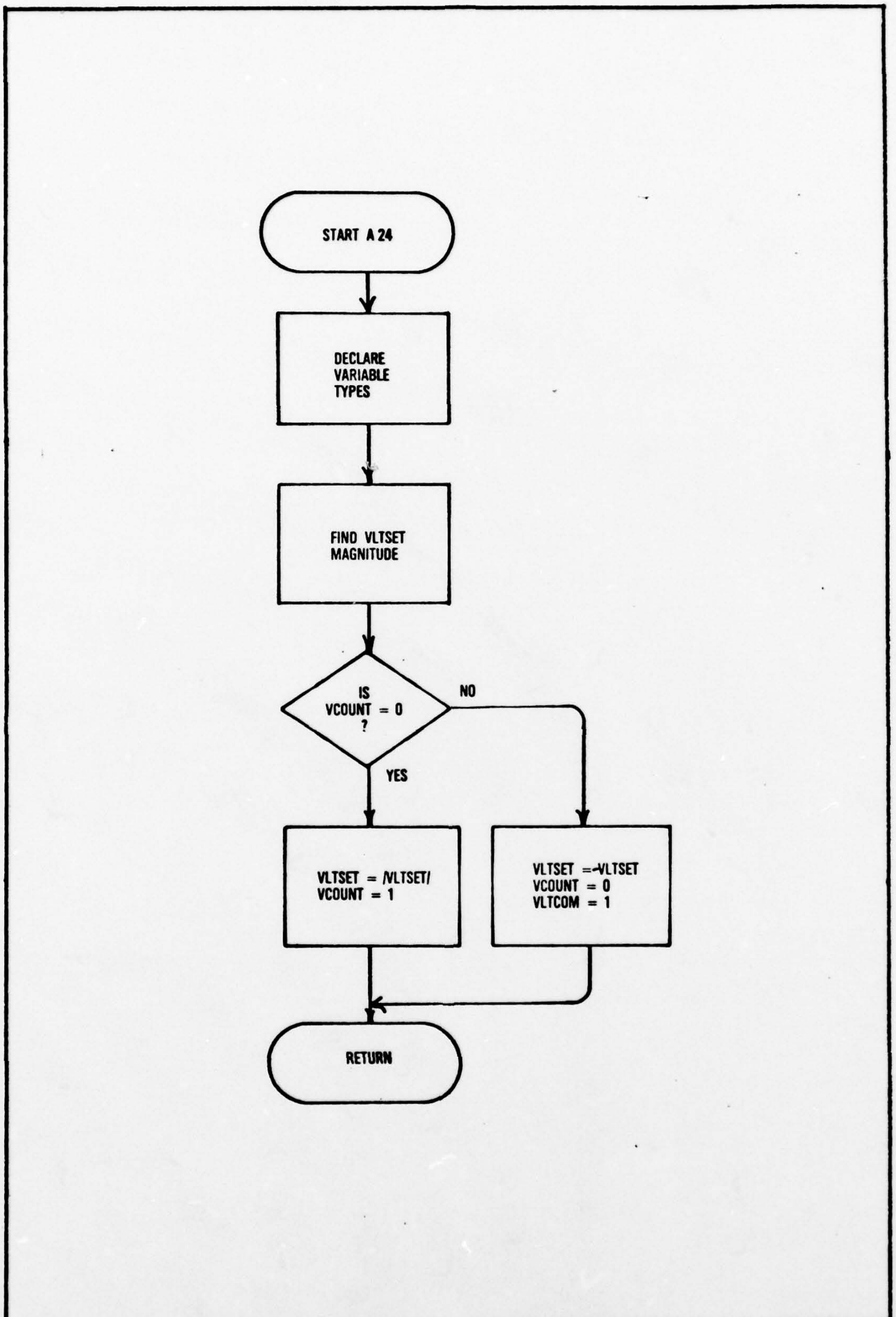


Figure 29. Flow Chart for Module A24

```
      SUBROUTINE A24
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A24---DETERMINE APPLIED VOLTAGE SETTINGS
C
C          THIS MODULE WILL DETERMINE WHAT VOLTAGE WILL BE
C APPLIED TO THE SAMPLE.  NORMALLY THIS WILL BE ONLY A POLARITY
C CHANGE.  THE MAGNITUDE WILL ONLY BE CHANGED AT USER DESIGNATED
C TEMPERATURE POINTS.
C
C
C          AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C DATA SPECIFICATIONS
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C DATAIN
      INTEGER ETYPE
      REAL TEMP(100),FIELD,AVLT(2,6)
C     THESE ARE THE DATA SPECIFICATIONS FOR A2
C
C     CONSIG
      INTEGER SDP,EXPC,FSCOM,SCSCOM,VLTCOM
C
C  A2COM
      INTEGER NTEM,SCSET,SCOUNT,VCOUNT,RUN
      REAL TEMSET,FLDSET,VLTSET,X0
C THE NAMED COMMON BLOCKS FOR A2CNN FOLLOW.
      COMMON /CONSIG/SDP,EXPC,FSCOM,SCSCOM,VLTCOM
      COMMON /A2COM/TEMSET,FLDSET,VLTSET,X0,NTEM,SCSET,SCOUNT,
     2VCOUNT,RUN
C THESE ARE THE COMMON BLOCKS FROM MODULE A1
      COMMON /DATAIN/NTEMPT,TEMP,ETYPE,FIELD,
     2NAVOLT,AVLT,NDATPT
C
C
C
C CHECK IF THE VOLTAGE MAGNITUDE NEEDS TO BE CHANGED
C
      DO 10 I=1,NAVOLT
         IF(TEMP(NTEM-1).GE.AVLT(1,I))VLTSET=AVLT(2,I)
10    CONTINUE
C VCOUNT IS THE FLAG THAT TELLS THE PROGRAM WHETHER THE VOLTAGE SHOULD
C BE POSITIVE OR NEGATIVE EACH PASS THROUGH THE PROGRAM.
C
      IF(VCOUNT.NE.0) GO TO 20
         VLTSET=ABS(VLTSET)
         VCOUNT=1
         GO TO 900
20    CONTINUE
         VLTSET=-VLTSET
```

```
            VCOUNT=0
            VLTCOM=1
  900    CONTINUE
         RETURN
         END
```

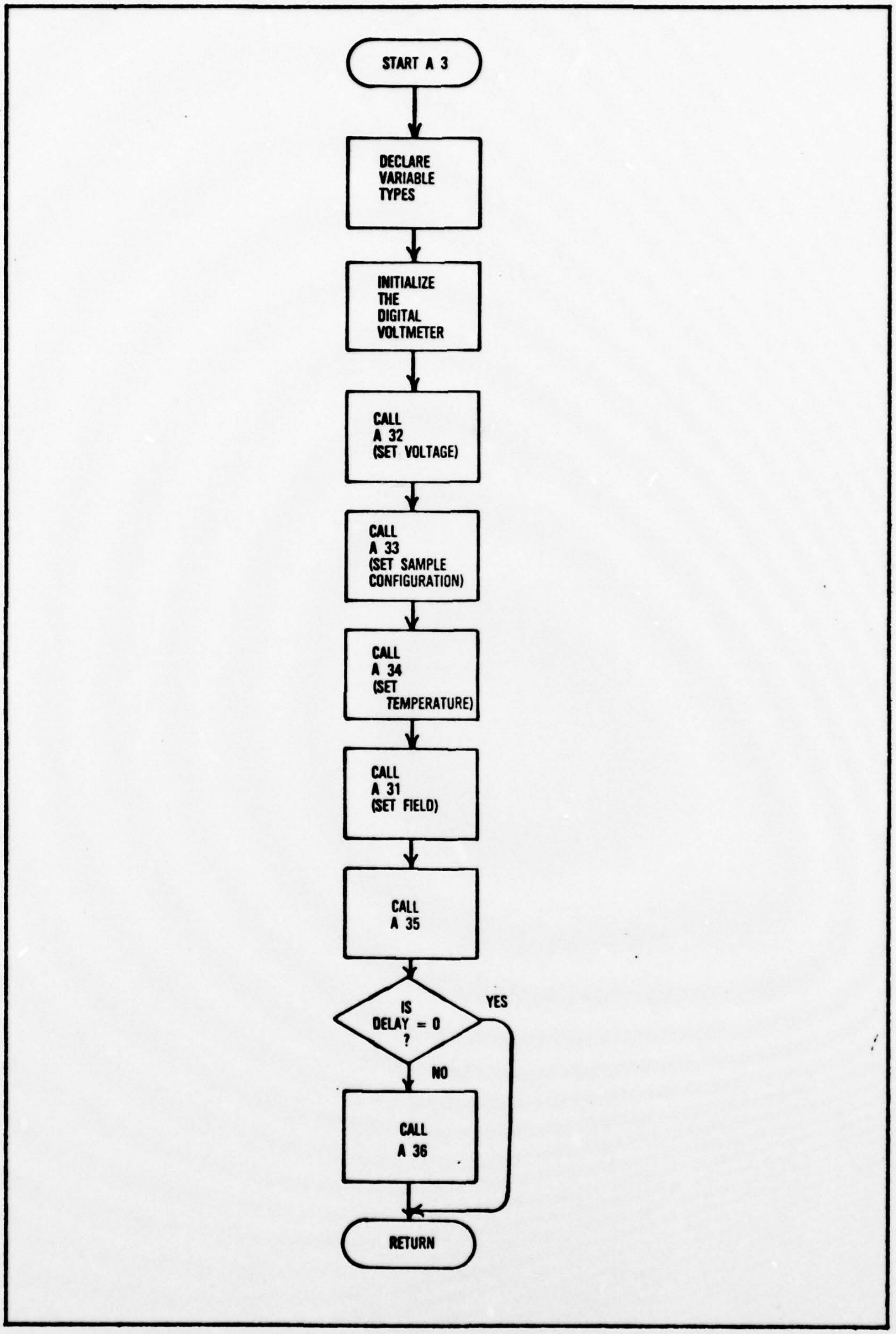


Figure 30. Flow Chart for Module A3

```
      SUBROUTINE A3
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A3---SET PARAMETERS
C
C     THIS MODULE IS THE EXECUTIVE FOR SET PARAMETERS.  IT CONTROLS
C WHICH MODULES OPERATE AND WHEN THEY DO SO.  SIX MODULES ARE
C SUBORDINATE TO A3:
C     A31---CHECK/SET FIELD
C     A32---CHECK/SET APPLIED VOLTAGE
C     A33---CHECK/SET SAMPLE CONFIGURATION
C     A34---CHECK/SET TEMPERATURE
C     A35---GENERATE ACQUIRE DATA SIGNAL
C     A36---DELAY RECHECK
C AS THE MODULE EXECUTES, A31 THROUGH A34 SET THEIR PARAMETER
C AND GENERATE EITHER A SETTLING TIME DELAY OR A PARAMETER OK SIGNAL.
C A31, CHECK/SET FIELD IS THE LAST TO SET ITS PARAMETER BECAUSE
C IT WILL AFFECT THE OTHER PARAMETERS IF THE FIELD IS ON.
C THE GENERATE AQUIRE DATA SIGNAL MODULE THEN CHECKS ALL OF THE
C PARAMETER OK SIGNAL IS GENERATED.  IF NOT CONTROL PASSES BACK
C TO DELAY RECHECK, WHICH PASSES CONTROL BACK TO THE TOP OF THE
C CHECK/SET LOOP AFTER DELAYING FOR THE LONGEST OF THE ESTIMATED
C SETTLING TIMES THAT WERE GENERATED.
C
C
C         AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR. USAF
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C DATA SPECIFICATIONS
C
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C EQPOUT
      BYTE EQUIPF(10,8)
      INTEGER IEIOF,EOFLAG(7)
C     THESE ARE THE DATA SPECIFICATIONS FOR A2
C  A2COM
      INTEGER NTEM,SCSET,SCOUNT,VCOUNT,RUN
      REAL TEMSET,FLDSET,VLTSET,X0
C THESE ARE THE DATA SPECIFICATIONS FOR A3
      INTEGER VLTAGE,TSTCON,MAGNET
C  A3COM
      INTEGER FDELAY,SAM,FLDOK,TEMOK,VLTOK,SAMOK,
     2VDELAY,SDELAY,TDELAY,DELAY
C GAUSSM
      REAL FLDRD
C DVMCOM
      INTEGER FUNC
      REAL TEMRD,VLTRD
C TSTCOM
      INTEGER SIGN
C THESE ARE THE COMMON BLOCKS FROM MODULE A1
```

```
      COMMON /EQPOUT/EOFLAG,EQUIPF,IEIOF
C THE NAMED COMMON BLOCKS FOR A2CMN FOLLOW.
      COMMON /A2COM/TEMSET,FLDSET,VLTSET,X0,NTEM,SCSET,SCOUNT,
     2VCOUNT,RUN
C THE COMMON BLOCKS FOR A3 FOLLOW
      COMMON /A3COM/FDELAY,VDELAY,SDELAY,TDELAY,DELAY,FLD,VLT,
     2TEM,FLDOK,TEMOK,VLTOK,SAMOK,SAM
      COMMON /DMMCOM/CRNTRD
      COMMON /GAUSSM/FLDRD
      COMMON /DVMCOM/FUNC,TEMRD,VLTRD
C
C
      DATA FLDOK,TEMOK,VLTOK,SAMOK/0,0,0,0/
      IF(EOFLAG(2).NE.0)GO TO 10
      A=DVM(0)
 10   CONTINUE
C START CHECKING THE PARAMETERS
C VOLTAGE
      CALL A32
C SAMPLE CONFIGURATION
      CALL A33
C TEMPERATURE
40    CONTINUE
      CALL A34
C FIELD
12    CONTINUE
      CALL A31
C NOW CHECK TO SEE OF ALL PARAMETERS ARE SET OK
C
50    CONTINUE
      CALL A35
      IF(DELAY.EQ.0)GO TO 900
C DELAY RECHECK
      CALL A36(DELAY)
900   CONTINUE
      RETURN
      END
```

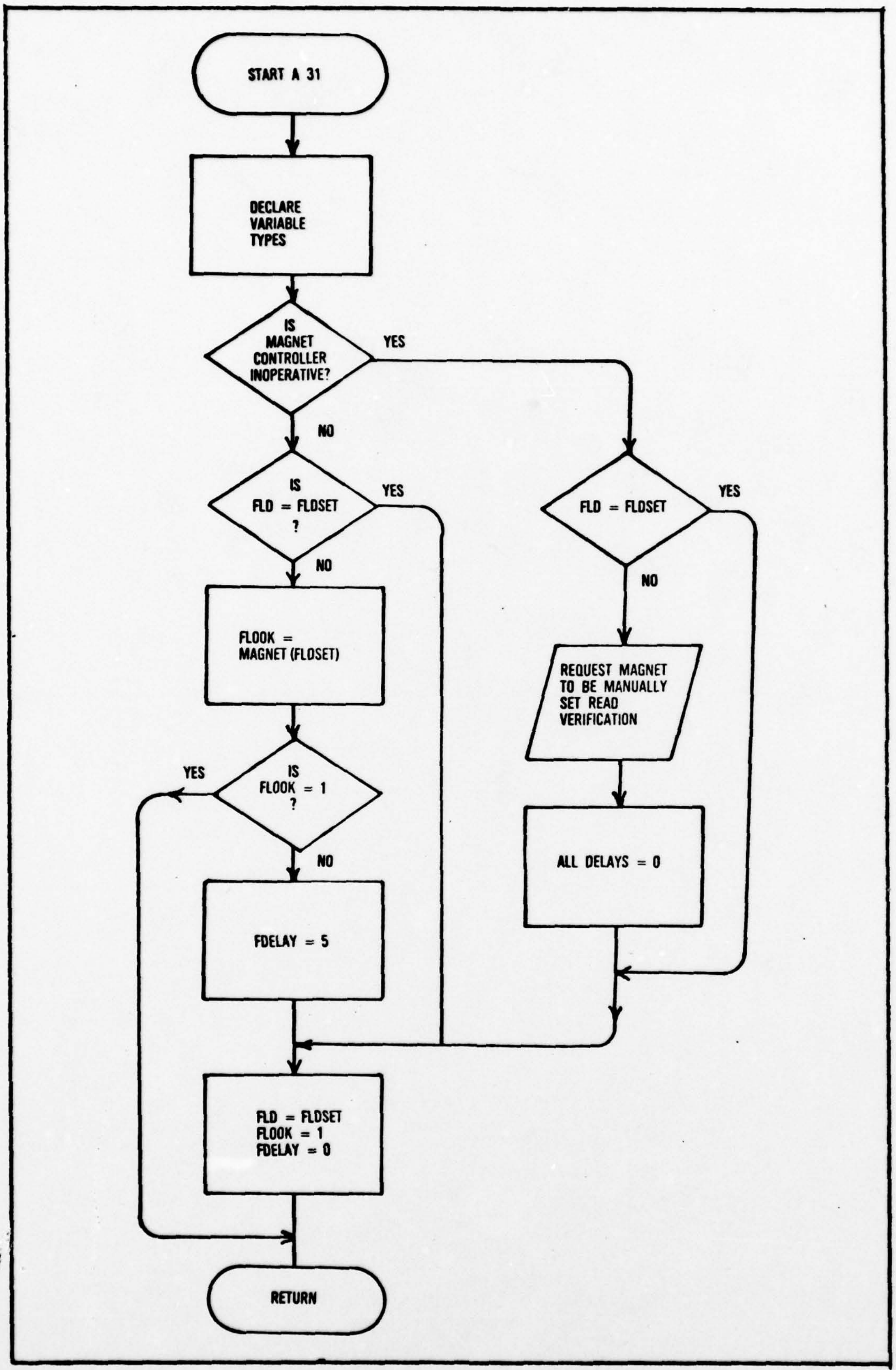


Figure 31. Flow Chart for Module A31

```
      SUBROUTINE A31
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A31---CHECK/SET FIELD
C
C THIS MODULE PASSES THE FIELD SETTING TO THE STEPPER
C MOTOR DRIVER PROGRAM WHICH CONTROLS THE SETTING OF
C THE MAGNET.  IT RECEIVES BACK AN ANTICIPATED DELAY AND A
C FIELD OK SIGNAL.  IF THE GAUSSMETER OR THE MAGNET CONTROL
C EQUIPMENT OUT FLAG IS SET INPUT FROM THE TERMINAL IS
C REQUIRED TO GET THE PROPER SETTING.
C
C
C        AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR.  USAF
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C DATA SPECIFICATIONS
C
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C EQPOUT
      BYTE EQUIPF(10,8)
      INTEGER IEIOF,EOFLAG(7)
C     THESE ARE THE DATA SPECIFICATIONS FOR A2
C  A2COM
      INTEGER NTEM,SCSET,SCOUNT,VCOUNT,RUN
      REAL TEMSET,FLDSET,VLTSET,X0
C THESE ARE THE DATA SPECIFICATIONS FOR A3
      INTEGER VLTAGE,TSTCON,MAGNET
C   A3COM
      INTEGER FDELAY,SAM,FLDOK,TEMOK,VLTOK,SAMOK,
     2VDELAY,SDELAY,TDELAY,DELAY
C GAUSSM
      REAL FLDRD
C THESE ARE THE COMMON BLOCKS FROM MODULE A1
      COMMON /EQPOUT/EOFLAG,EQUIPF,IEIOF
C THE NAMED COMMON BLOCKS FOR A2CMN FOLLOW.
      COMMON /A2COM/TEMSET,FLDSET,VLTSET,X0,NTEM,SCSET,SCOUNT,
     2VCOUNT,RUN
C THE COMMON BLOCKS FOR A3 FOLLOW
      COMMON /A3COM/FDELAY,VDELAY,SDELAY,TDELAY,DELAY,FLD,VLT,
     2TEM,FLDOK,TEMOK,VLTOK,SAMOK,SAM
      COMMON /GAUSSM/FLDRD
C
C CHECK EQUIPMENT OUT FLAGS
      IF(EOFLAG(5).EQ.1) GO TO 10
C SET THE FIELD AUTOMATICALLY BY CALLING MAGNET
C IF THE PREVIOUS SETTING AND THE NEW SETTING ARE THE SAME DON'T
C BOTHER TO CALL MAGNET.
      IF(FLD.EQ.FLDSET)GO TO 20
      FLDOK=MAGNET(FLDSET,FLD)
C DELAY IS EQUAL TO 2 SECONDS PER KGAUSS SETTING
```

```
      IF(FLDOK.NE.1)FDELAY=5
      GO TO 21
10    CONTINUE
      IF(FLD.EQ.FLDSET) GO TO 20
         WRITE(7,1000) FLDSET
1000     FORMAT(' ',' SET THE MAGNET TO ',G14.7,' KGAUSS '/
     1          ' CARRIAGE RETURN WHEN SET ',$)
         PAUSE
C IF FIELD IS MANUAL ZERO ALL OF THE DELAYS.  THEY WILL NOT
C BE NEEDED
         FDELAY=0
         SDELAY=0
         TDELAY=0
         VDELAY=0
20    CONTINUE
         FLDOK=1
         FDELAY=0
21    CONTINUE
      FLD=FLDSET
900   CONTINUE
      RETURN
      END
```

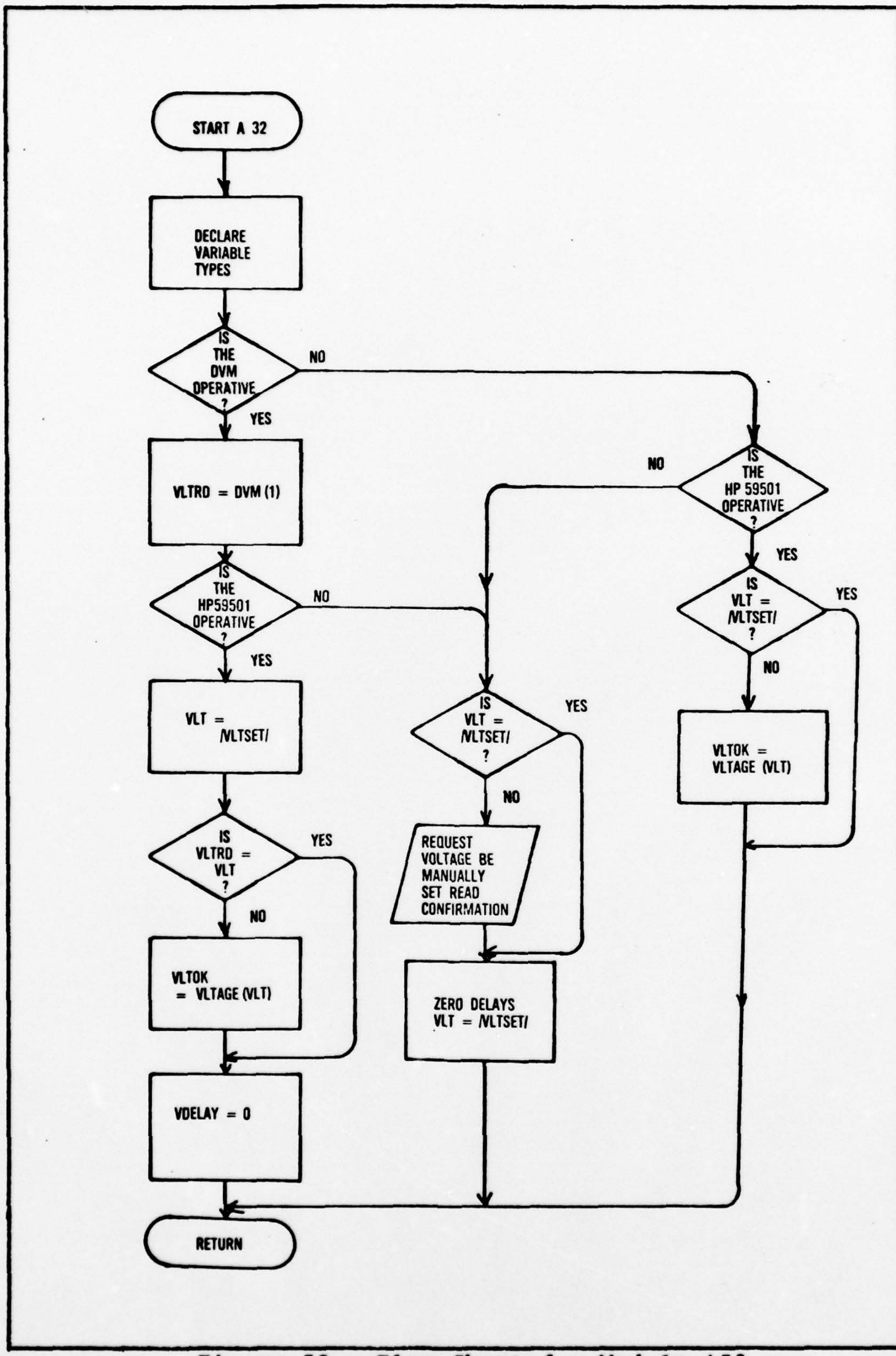


Figure 32. Flow Chart for Module A32

```
      SUBROUTINE A32
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A32---CHECK/SET APPLIED VOLTAGE
C
C     THIS MODULE CALLS THE DRIVER PROGRAM FOR THE POWER SUPPLY
C WHICH SETS THE APPLIED VOLTAGE TO THE SAMPLE.  THIS VALUE IS
C CROSS CHECKED FOR ACCURACY ON THE DIGITAL VOLTMETER.  IF
C THE DVM EQUIPMENT OUT FLAG IS SET THE APPLIED VOLTAGE READING IS
C ASSUMED TO BE VLTSET.  THIS IS A GOOD ASSUMPTION BECAUSE THIS
C VALUE RELATIVELY STABLE.  IF THE POWER SUPPLY IS INOPERATIVE
C THE OPERATOR IS REQUIRED TO MAKE THE SETTING BY A MESSAGE TO THE
C TERMINAL.
C
C
C        AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C DATA SPECIFICATIONS
C
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C EQPOUT
      BYTE EQUIPF(10,8)
      INTEGER IEIOF,EOFLAG(7)
C     THESE ARE THE DATA SPECIFICATIONS FOR A2
C  A2COM
      INTEGER NTEM,SCSET,SCOUNT,VCOUNT,RUN
      REAL TEMSET,FLDSET,VLTSET,X0
C THESE ARE THE DATA SPECIFICATIONS FOR A3
      INTEGER VLTAGE,TSTCON,MAGNET
C   A3COM
      INTEGER FDELAY,SAM,FLDOK,TEMOK,VLTOK,SAMOK,
     2VDELAY,SDELAY,TDELAY,DELAY
C DVMCOM
      INTEGER FUNC
      REAL TEMRD,VLTRD
C THESE ARE THE COMMON BLOCKS FROM MODULE A1
      COMMON /EQPOUT/EOFLAG,EQUIPF,IEIOF
C THE NAMED COMMON BLOCKS FOR A2CMN FOLLOW.
      COMMON /A2COM/TEMSET,FLDSET,VLTSET,X0,NTEM,SCSET,SCOUNT,
     2VCOUNT,RUN
C THE COMMON BLOCKS FOR A3 FOLLOW
      COMMON /A3COM/FDELAY,VDELAY,SDELAY,TDELAY,DELAY,FLD,VLT,
     2TEM,FLDOK,TEMOK,VLTOK,SAMOK,SAM
      COMMON /DVMCOM/FUNC,TEMRD,VLTRD
C
C
C
10    CONTINUE
C CHECK THE EQUIPMENT OUT FLAG FOR THE DIGITAL VOLTMETER
      IF(EOFLAG(2).EQ.1) GO TO 500
```

```
C CHECK THEVOLTAGE AGAINST THE VOLTAGE SETTING
      VLTRD=DVM(1)
C CHECK TO SEE IF THE POWER SUPPLY IS OPERATIVE
      IF(EOFLAG(4).EQ.1) GO TO 600
        VLT=ABS(VLTSET)
        IF(VLTRD.NE.VLT) VLTOK=VLTAGE(VLT)
        VDELAY=0
        GO TO 900
500   CONTINUE
        IF(EOFLAG(4).EQ.1) GO TO 600
           IF(VLT.NE.ABS(VLTSET)) VLTOK=VLTAGE(VLT)
         GO TO 900
600   CONTINUE
        IF(VLT.EQ.ABS(VLTSET)) GO TO 20
         WRITE(7,1000) VLTSET
1000     FORMAT(' ',' PLEASE SET  ',G14.7,'  VOLTS'/
     1              '  CARRIAGE RETURN WHEN SET',$)
             PAUSE
20       CONTINUE
          VDELAY=0
          FDELAY=0
          VLTOK=1
      VLT=ABS(VLTSET)
900   CONTINUE
      RETURN
      END
```

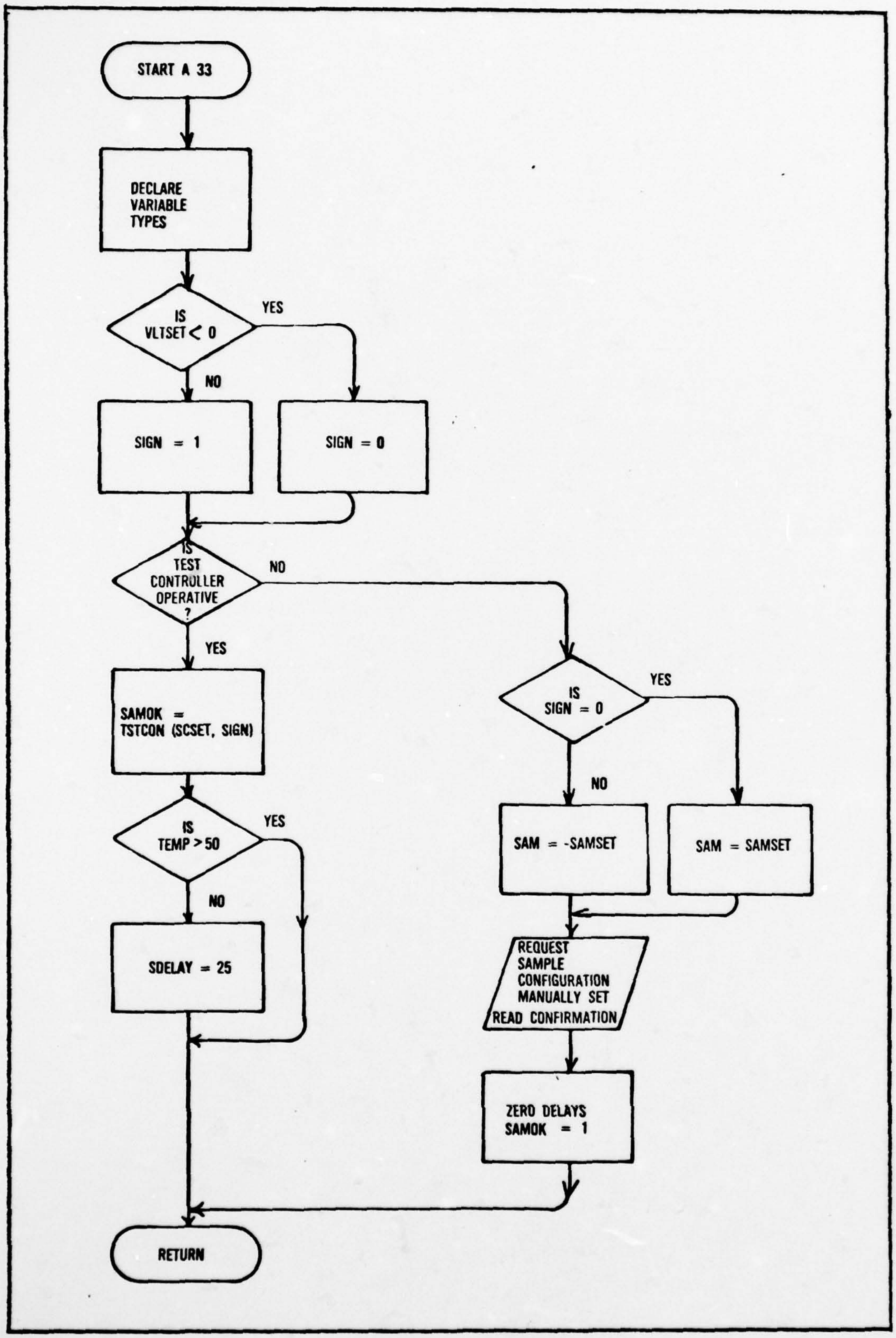


Figure 33. Flow Chart for Module A33

```
      SUBROUTINE A33
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A33---CHECK/SET SAMPLE CONFIGURATION
C
C     THIS MODULE CALLS THE DRIVER SUBPROGRAM FOR THE TEST CONTROLLER
C WHICH SETS THE SAMPLE CONFIGURATION.  THE POLARITY OF THE APPLIED
C VOLTAGE IS ALSO SET HERE ON THE TEST CONTROLLER.  IF THE TEST
C CONTROLLER IS INOPERATIVE, A MANUAL SETTING IS REQUESTED ON THE
C TERMINAL.  THE PROGRAM, THEN SETS THE SETTLING DELAY TIME.
C
C
C          AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C DATA SPECIFICATION
C
C
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C EQPOUT
      BYTE EQUIPF(10,8)
      INTEGER IEIOF,EOFLAG(7)
C     THESE ARE THE DATA SPECIFICATIONS FOR A2
C  A2COM
      INTEGER NTEM,SCSET,SCOUNT,VCOUNT,RUN
      REAL TEMSET,FLDSET,VLTSET,X0
C THESE ARE THE DATA SPECIFICATIONS FOR A3
      INTEGER VLTAGE,TSTCON,MAGNET
C   A3COM
      INTEGER FDELAY,SAM,FLDOK,TEMOK,VLTOK,SAMOK,
     2VDELAY,SDELAY,TDELAY,DELAY
C TSTCOM
      INTEGER SIGN
C RAWDAT
      REAL TEMDAT(20),VLTDAT(20),SVDATA(20),FLDATA(20),IDATA(20)
      INTEGER SCDATA(20)
      COMMON /RAWDAT/TEMDAT,VLTDAT,SVDATA,FLDATA,IDATA,SCDATA
C THESE ARE THE COMMON BLOCKS FROM MODULE A1
      COMMON /EQPOUT/EOFLAG,EQUIPF,IEIOF
C THE NAMED COMMON BLOCKS FOR A2CMN FOLLOW.
      COMMON /A2COM/TEMSET,FLDSET,VLTSET,X0,NTEM,SCSET,SCOUNT,
     2VCOUNT,RUN
C THE COMMON BLOCKS FOR A3 FOLLOW
      COMMON /A3COM/FDELAY,VDELAY,SDELAY,TDELAY,DELAY,FLD,VLT,
     2TEM,FLDOK,TEMOK,VLTOK,SAMOK,SAM
C
C
C
C
C CHECK POLARITY
      IF(VLTSET.LT.0.0)GO TO 20
```

```
              SIGN=0
              GO TO 25
      20    CONTINUE
              SIGN=1
      25    CONTINUE
      C         CHECK EQUIPMENT OUT FLAG
                IF(EOFLAG(6).EQ.1) GO TO 500
      C SET THE TEST CONTROLLER
                   SAMOK=TSTCON(SCSET,SIGN)
      C SET THE DELAY VALUE
                       IF(IDATA(RUN-1).GT.5.0E-8)GO TO 10
                          SDELAY=25
                          GO TO 900
      10               CONTINUE
                             SDELAY=5
                        GO TO 900
      500       CONTINUE
                   IF(SIGN.LT.1) GO TO 30
                        GO TO 35
      30           CONTINUE
                        SAM=-SCSET
      35           CONTINUE
                        SAM=SCSET
                        WRITE(7,5000) SAM
      5000              FORMAT(' ',' SET THE TEST CONTROLLER TO
           1                            SAMPLE CONFIGURATION  ',I3,/
           2                      ' CARRIAGE RETURN WHEN SET',$)
                        PAUSE
                        SAMOK=1
                        SDELAY=0
                        VDELAY=0
                        FDELAY=0
      900   CONTINUE
            RETURN
            END
```

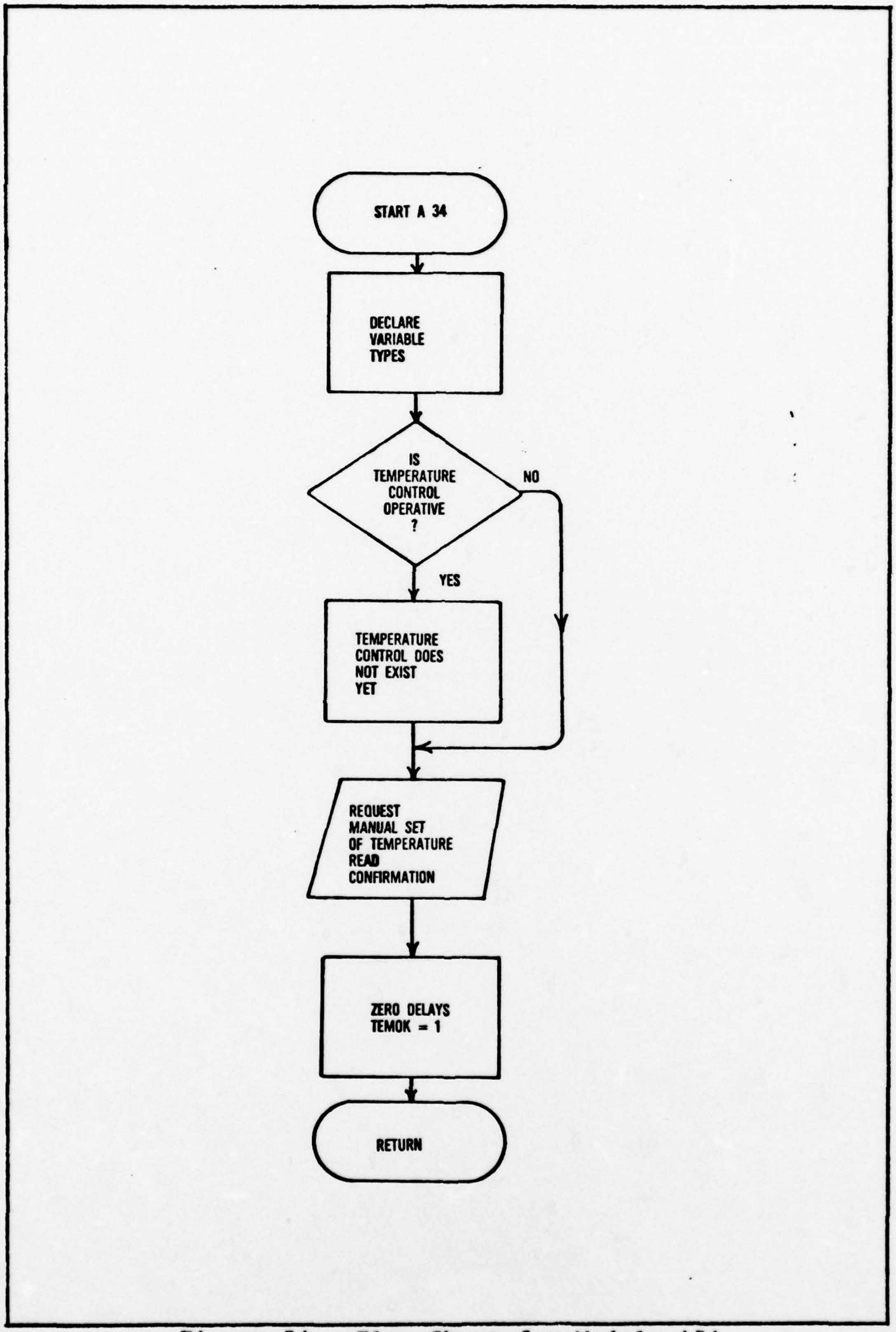


Figure 34. Flow Chart for Module A34

```
      SUBROUTINE A34
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A34---CHECK/SET TEMPERATURE
C
C     THIS MODULE WILL SET THE HEATER VOLTAGE ON THE HEATER
C POWER SUPPLY TO THE PROPER VALUE TO STABILIZE THE SAMPLE
C AT THE DESIRED STEADY STATE TEMPERATURE.  IF THE EQUIPMENT
C OUT FLAG IS SET, A MESSAGE WILL DIRECT THE OPERATOR  TO SET THE
C TEMPERATURE TO THE PROPER SETTING.
C
C        AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C DATA SPECIFICAIONS
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C EQPOUT
      BYTE EQUIPF(10,8)
      INTEGER IEIOF,EOFLAG(7)
C     THESE ARE THE DATA SPECIFICATIONS FOR A2
C  A2COM
      INTEGER NTEM,SCSET,SCOUNT,VCOUNT,RUN
      REAL TEMSET,FLDSET,VLTSET,X0
C THESE ARE THE DATA SPECIFICATIONS FOR A3
      INTEGER VLTAGE,TSTCON,MAGNET
C   A3COM
      INTEGER FDELAY,SAM,FLDOK,TEMOK,VLTOK,SAMOK,
     2VDELAY,SDELAY,TDELAY,DELAY
C DVMCOM
      INTEGER FUNC
      REAL TEMRD,VLTRD
C THESE ARE THE COMMON BLOCKS FROM MODULE A1
      COMMON /EQPOUT/EOFLAG,EQUIPF,IEIOF
C THE NAMED COMMON BLOCKS FOR A2CMN FOLLOW.
      COMMON /A2COM/TEMSET,FLDSET,VLTSET,X0,NTEM,SCSET,SCOUNT,
     2VCOUNT,RUN
C THE COMMON BLOCKS FOR A3 FOLLOW
      COMMON /A3COM/FDELAY,VDELAY,SDELAY,TDELAY,DELAY,FLD,VLT,
     2TEM,FLDOK,TEMOK,VLTOK,SAMOK,SAM
      COMMON /DVMCOM/FUNC,TEMRD,VLTRD
C
C
C
C CHECK EQUIPMENT OUT FLAG
      IF(EOFLAG(3).EQ.1) GO TO 500
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C THE HEATER CONTROL DOES NOT EXIST YET.  WILL BE PLACED HERE
C IN PROGRAM WHEN IMPLEMENTED.
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
  500 CONTINUE
      IF(RUN.NE.1.AND.RUN.NE.6.AND.RUN.NE.11.AND.RUN.NE.16)GO TO 10
```

```
          WRITE(7,5000) TEMSET
    5000  FORMAT(' ',' SET THE TEMPERATURE AS READ BY THE SILICON'/
     1          ' THERMOMETER TO APPROXIMATELY',G14.7,'  VOLTS'/
     2            ' CARRIAGE RETURN WHEN SET',$)
          PAUSE
C SET THE DELAYS TO ZERO IF TEMPERATURE IS RESET MANUALLY
          TDELAY=0
          FDELAY=0
          SDELAY=0
          VDELAY=0
    10    CONTINUE
          TEMOK=1
    900   CONTINUE
          RETURN
          END
```

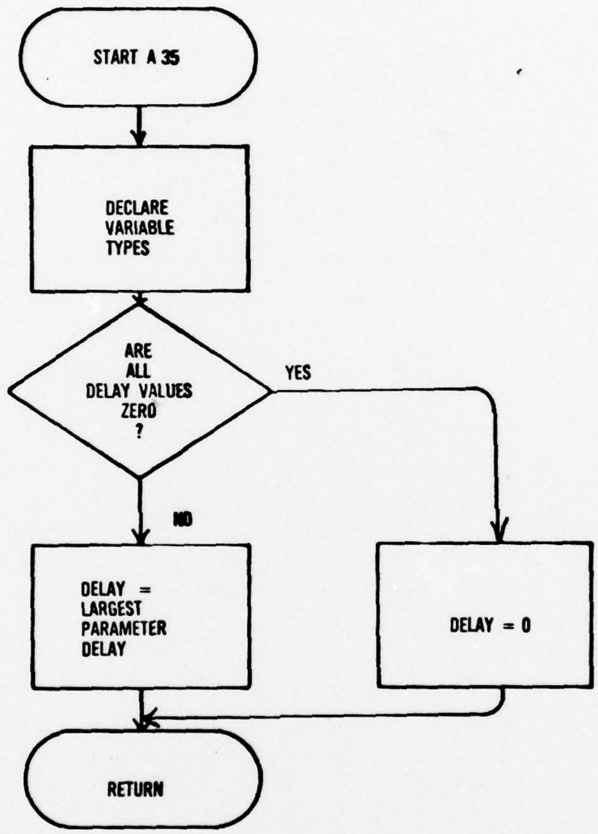


Figure 35. Flow Chart for Module A35

```
      SUBROUTINE A35
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A35---GENERATE AQUIRE DATA SIGNAL
C
C     THIS MODULE CHECKS ALL OF THE PARAMETER OK SIGNALS
C AND IF ALL ARE TRUE, GENERATES THE START DATA ACQUISITION
C SIGNAL.  IF ALL ARE NOT TRUE, IT CALLS THE DELAY RECHECK
C MODULE.
C
C        AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR.  USAF
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C DATA SPECCIFICATIONS
C THESE ARE THE DATA SPECIFICATIONS FOR A3
C   A3COM
      INTEGER FDELAY,SAM,FLDOK,TEMOK,VLTOK,SAMOK,
     2VDELAY,SDELAY,TDELAY,DELAY
C THE COMMON BLOCKS FOR A3 FOLLOW
      COMMON /A3COM/FDELAY,VDELAY,SDELAY,TDELAY,DELAY,FLD,VLT,
     2TEM,FLDOK,TEMOK,VLTOK,SAMOK,SAM
C
C USE A3COM
C CHECK ALL OF THE PARAMETER OK SIGNALS
      IF(FDELAY.NE.0.AND.VDELAY.NE.0.AND.SDELAY.NE.0.AND.TDELAY.NE.0)
     1 GO TO 500
C SET THE DELAY
      IF(TDELAY.GT.FDELAY)GO TO 10
         DELAY=FDELAY
         GO TO 20
10    CONTINUE
         DELAY=TDELAY
20    CONTINUE
        IF(SDELAY.GT.DELAY) DELAY=SDELAY
         IF(VDELAY.GT.DELAY) DELAY=VDELAY
         GO TO 900
500   CONTINUE
        DELAY=5
900   CONTINUE
C RESET THE DELAY VALUES TO ZERO
          SDELAY=0
          TDELAY=0
          VDELAY=0
          FDELAY=0
      RETURN
      END
```

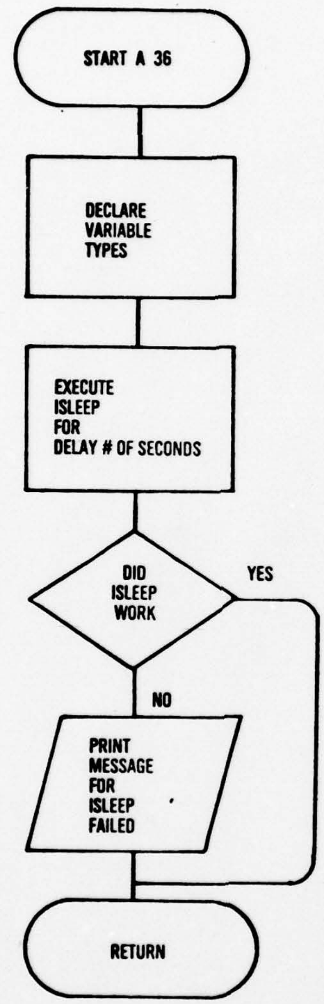


Figure 36. Flow Chart for Module A36

```
      SUBROUTINE A36(DELAY)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A36---DELAY RECHECK
C
C     THIS MODULE IS CALLED TO DELAY THE RECHECKING OF PARAMETERS.
C IF SIMPLY WAITS FOR THENUMBER OF SECONDS SPECIFIED BY THE DELAY
C PARAMETER BEFORE RETURNING.
C
C
C        AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      INTEGER DELAY
C CONVERT DELAY TO MINUTES AND SECONDS
      M=DELAY/60
      IS=DELAY-60*M
C NOW DELAY
      I=ISLEEP(0,M,IS,0)
      IF(I.NE.0)GO TO 800
      GO TO 900
800   CONTINUE
      WRITE(7,8000)
8000  FORMAT(' ',' ISLEEP IN THE A36 MODULE FAILED')
900   CONTINUE
      RETURN
      END
```

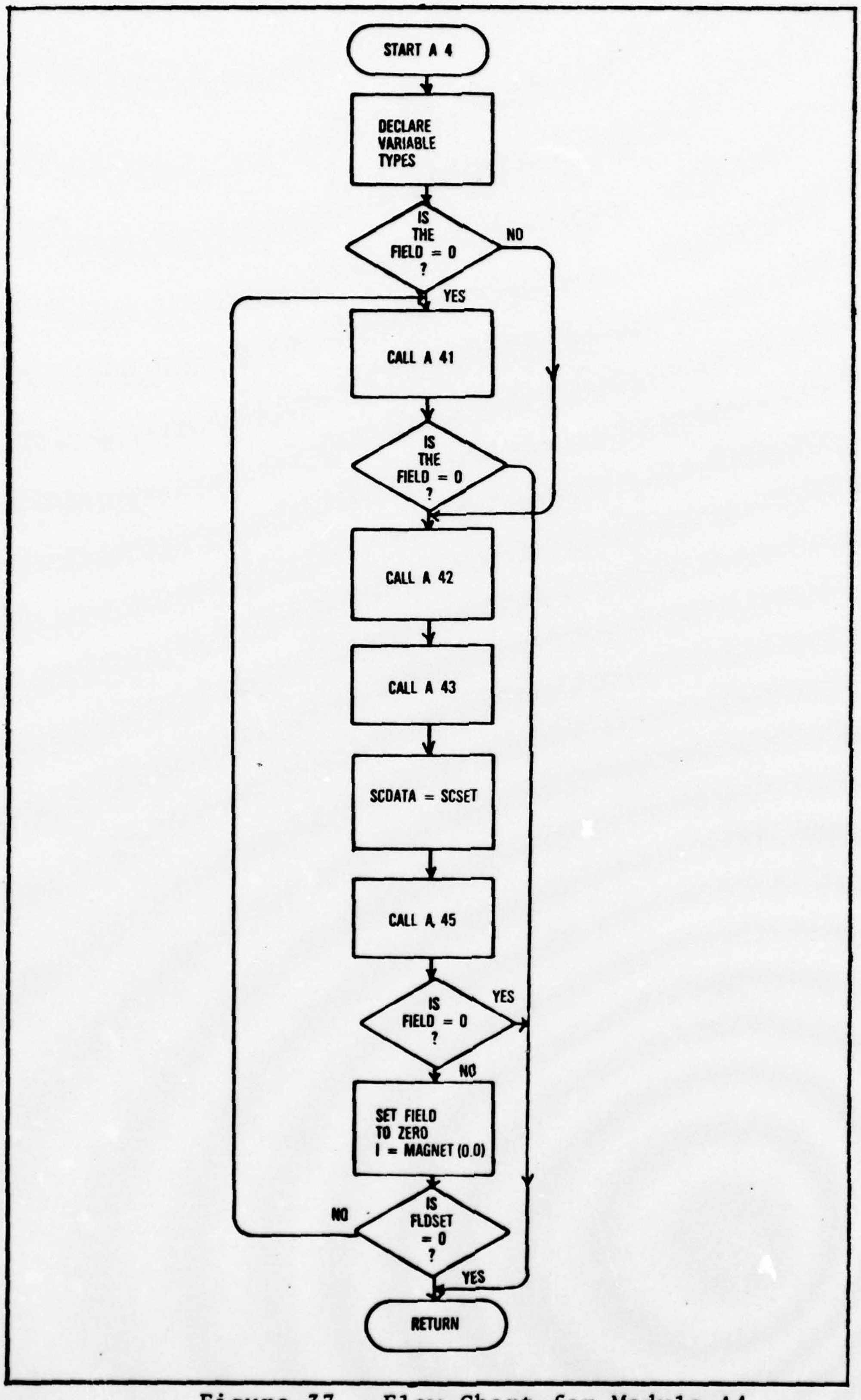


Figure 37. Flow Chart for Module A4

```
      SUBROUTINE A4
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A4---ACQUIRE DATA
C
C       MODULE A4 IS THE EXECUTIVE FOR ACQUIRE DATA.  IT CALLS
C FOUR SUBORDINATE MODULES:
C      A41---READ TEMPERATURE
C      A42---READ CURRENT
C      A43---READ APPLIED AND SAMPLE VOLTAGE
C      A45---READ FIELD
C (A44 WAS DELETED INTENTIONALLY BECAUSE IT WAS TRIVIAL)
C EACH OF THESE MODULES READS THE DESIRED PARAMETER(S) FROM THE
C APPROPRIATE DRIVER SUBROUTINE(S) AND RETURNS THE DATA TO A4.
C A4 THEN PASSES IT BACK AND GENERATES THE DATA ACQUISITION
C COMPLETE SIGNAL  IF THE FIELD IS ON, THE MODULE SKIPS A41 UNTIL
C AFTER A45.  IT THEN TURNS THE FIELD OFF AND READS THE
C TEMPERATURE.
C
C          AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C DATA SPECIFICATIONS
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C EQPOUT
      BYTE EQUIPF(10,8)
      INTEGER IEIOF,EOFLAG(7)
C     THESE ARE THE DATA SPECIFICATIONS FOR A2
C
C  A2COM
      INTEGER NTEM,SCSET,SCOUNT,VCOUNT,RUN
      REAL TEMSET,FLDSET,VLTSET,X0
C THESE ARE THE DATA SPECIFICATIONS FOR A3
      INTEGER VLTAGE,TSTCON,MAGNET
C A3COM
      INTEGER FDELAY,SAM,FLDOK,TEMOK,VLTOK,SAMOK,
     2VDELAY,SDELAY,TDELAY,DELAY
C DVMCOM
      INTEGER FUNC
      REAL TEMRD,VLTRD
C THESE ARE THE DATA SPECIFICATIONS FOR A4
C     RAWDAT
      REAL TEMDAT(20),VLTDAT(20),SVDATA(20),FLDATA(20),IDATA(20)
      INTEGER SCDATA(20)
C THESE ARE THE COMMON BLOCKS FROM MODULE A1
      COMMON /EQPOUT/EOFLAG,EQUIPF,IEIOF
C THE NAMED COMMON BLOCKS FOR A2CMN FOLLOW.
      COMMON /A2COM/TEMSET,FLDSET,VLTSET,X0,NTEM,SCSET,SCOUNT,
     2VCOUNT,RUN
C THE COMMON BLOCKS FOR A3 FOLLOW
      COMMON /A3COM/FDELAY,VDELAY,SDELAY,TDELAY,DELAY,FLD,VLT,
     2TEM,FLDOK,TEMOK,VLTOK,SAMOK,SAM
      COMMON /DVMCOM/FUNC,TEMRD,VLTRD
```

```
C THE COMMON BLOCKS FOR A4 FOLLOW
      COMMON /RAWDAT/TEMDAT,VLTDAT,SVDATA,FLDATA,IDATA,SCDATA
C
C
C
C NOW READ THE TEMPERATURE
      IF(FLDSET.NE.0.0)GO TO 20
10       CONTINUE
         CALL A41
         IF(FLDSET.NE.0.0) GO TO 900
C READ THE CURRENT
20    CONTINUE
         CALL A42
C        READ THE APPLIED AND SAMPLE VOLTAGES
         CALL A43
C        READ THE SAMPLE CONFIGURATION
         SCDATA(RUN)=SCSET
         IF(VLTSET.LT.0.0)SCDATA(RUN)=-SCDATA(RUN)
C         READ THE FIELD
         CALL A45
C        SET THE FIELD TO ZERO IF NECESSARY TO READ THERMOMETER
        IF(FLDSET.EQ.0.0)GO TO 900
         I=MAGNET(0.0,FLD)
         IF(FLDSET.NE.0.0)GO TO 10
900   CONTINUE
      RETURN
      END
```

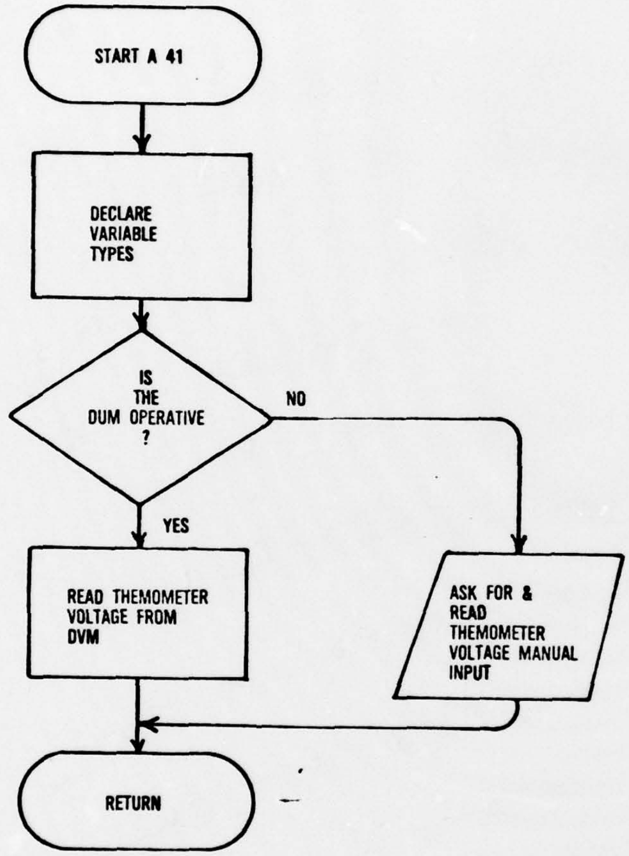


Figure 38. Flow Chart for Module A41

```
      SUBROUTINE A41
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A41---READ TEMPERATURE
C
C      THIS MODULE READS THE VOLTAGE OF THE SILICON THERMOMETER FROM
C THE DIGITAL VOLTMETER.
C IF THE DVM IS INOPERATIVE IT REQUESTS THE VALUE FROM THE
C OPERATOR ON THE TERMINAL.
C
C
C         AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C DATA SPECIFICATIONS
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C EQPOUT
      BYTE EQUIPF(10,8)
      INTEGER IEIOF,EOFLAG(7)
C     THESE ARE THE DATA SPECIFICATIONS FOR A2
C
C  A2COM
      INTEGER NTEM,SCSET,SCOUNT,VCOUNT,RUN
      REAL TEMSET,FLDSET,VLTSET,X0
C THESE ARE THE DATA SPECIFICATIONS FOR A3
      INTEGER VLTAGE,TSTCON,MAGNET
C DVMCOM
      INTEGER FUNC
      REAL TEMRD,VLTRD
C THESE ARE THE DATA SPECIFICATIONS FOR A4
C     RAWDAT
      REAL TEMDAT(20),VLTDAT(20),SVDATA(20),FLDATA(20),IDATA(20)
      INTEGER SCDATA(20)
C THESE ARE THE COMMON BLOCKS FROM MODULE A1
      COMMON /EQPOUT/EOFLAG,EQUIPF,IEIOF
C THE NAMED COMMON BLOCKS FOR A2CMN FOLLOW.
      COMMON /A2COM/TEMSET,FLDSET,VLTSET,X0,NTEM,SCSET,SCOUNT,
     2VCOUNT,RUN
C THE COMMON BLOCKS FOR A3 FOLLOW
      COMMON /DVMCOM/FUNC,TEMRD,VLTRD
C THE COMMON BLOCKS FOR A4 FOLLOW
      COMMON /RAWDAT/TEMDAT,VLTDAT,SVDATA,FLDATA,IDATA,SCDATA
C
C CHECK IF DVM IS OPERATIVE
      IF(EOFLAG(2).EQ.2) GO TO 20
C INTERROGATE THE DVM TO DETERMINE TEMPERATURE
        TEMRD=DVM(3)
        TEMDAT(RUN)=TEMRD
        GO TO 900
20    CONTINUE
        WRITE(7,2000)
2000    FORMAT(' ',' ENTER THE CURRENT VOLTAGE READING ON THE
     2SILICON THERMOMETER ')
```

```
        READ(5,*) TEMDAT(RUN)
  900 CONTINUE
      RETURN
      END
```

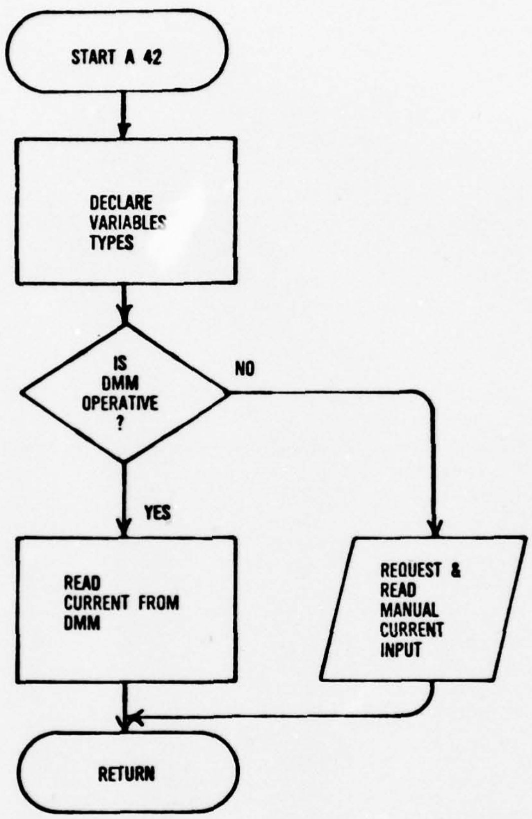


Figure 39. Flow Chart for Module A42

```
      SUBROUTINE A42
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A42---READ CURRENT
C
C     THIS MODULE READS THE SAMPLE CURRENT FROM THE ELECTROMETER.
C IF THE DMM(ELECTROMETER) IS INOPERATIVE, IT REQUESTS THE
C OPERATOR TO ENTER THE VALUE ON THE TERMINAL.
C
C
C        AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C EQPOUT
      BYTE EQUIPF(10,8)
      INTEGER IEIOF,EOFLAG(7)
C     THESE ARE THE DATA SPECIFICATIONS FOR A2
C
C  A2COM
      INTEGER NTEM,SCSET,SCOUNT,VCOUNT,RUN
      REAL TEMSET,FLDSET,VLTSET,X0
C THESE ARE THE DATA SPECIFICATIONS FOR A3
      INTEGER VLTAGE,TSTCON,MAGNET
C DMMCOM
      REAL CRNTRD
C THESE ARE THE DATA SPECIFICATIONS FOR A4
C     RAWDAT
      REAL TEMDAT(20),VLTDAT(20),SVDATA(20),FLDATA(20),IDATA(20)
      INTEGER SCDATA(20)
C THESE ARE THE COMMON BLOCKS FROM MODULE A1
      COMMON /EQPOUT/EOFLAG,EQUIPF,IEIOF
C THE NAMED COMMON BLOCKS FOR A2CMN FOLLOW.
      COMMON /A2COM/TEMSET,FLDSET,VLTSET,X0,NTEM,SCSET,SCOUNT,
     2VCOUNT,RUN
C THE COMMON BLOCKS FOR A3 FOLLOW
      COMMON /DMMCOM/CRNTRD
C THE COMMON BLOCKS FOR A4 FOLLOW
      COMMON /RAWDAT/TEMDAT,VLTDAT,SVDATA,FLDATA,IDATA,SCDATA
C
C CHECK IF THE ELECTROMETER IS INOPERATIVE
      IF(EOFLAG(1).EQ.1)GO TO 10
        CRNTRD=DMM(C)
        IDATA(RUN)=CRNTRD
        GO TO 900
10    CONTINUE
C GET THE VALUE OF CURRENT IF THE DMM IS INOPERATIVE
        WRITE(7,1000)
1000    FORMAT(' ',' ENTER THE SAMPLE CURRENT ')
        READ(5,*) IDATA(RUN)
900   CONTINUE
      RETURN
```

0025 END

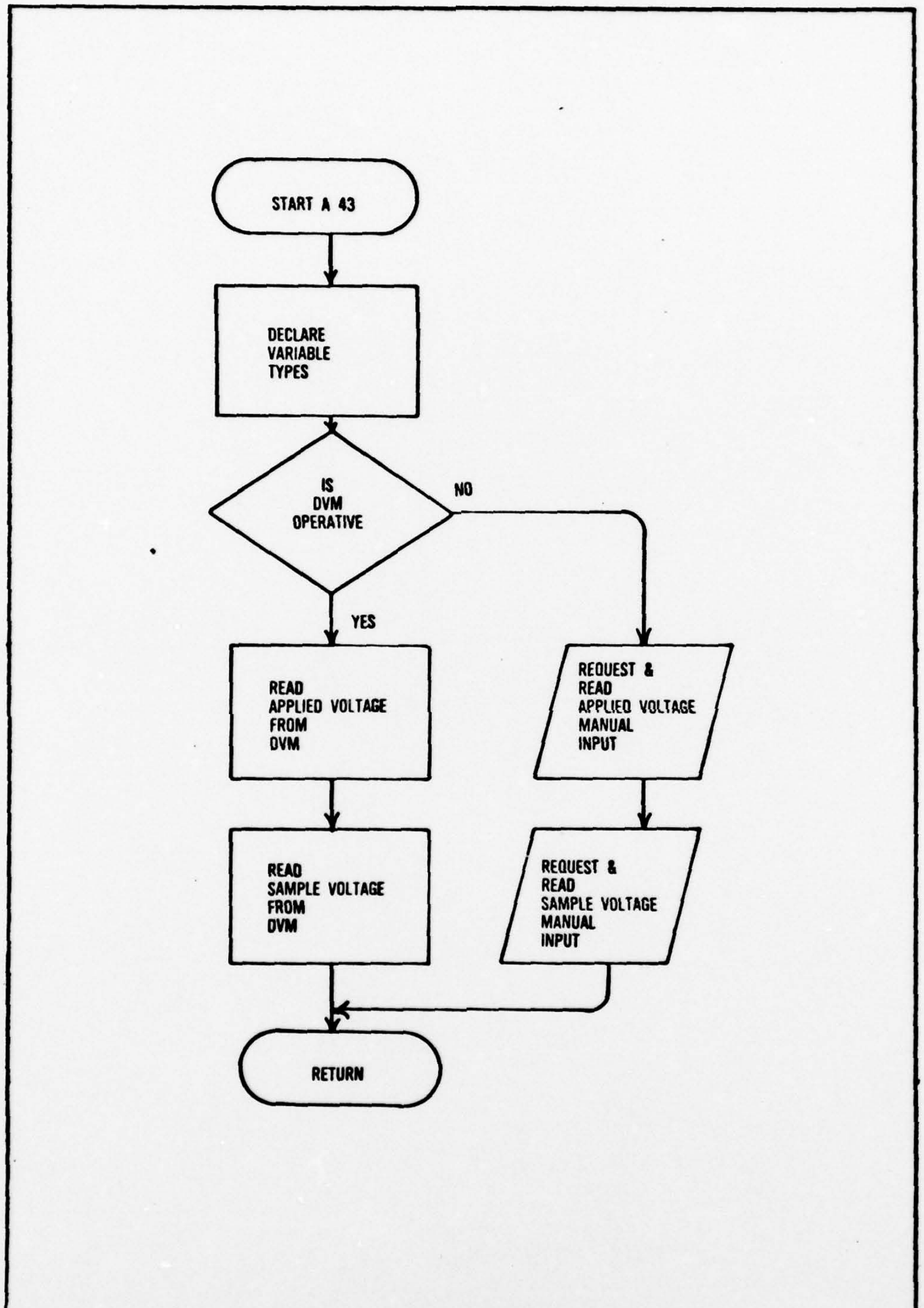


Figure 40. Flow Chart for Module A43

```
      SUBROUTINE A43
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A43---READ APPLIED AND SAMPLE VOLTAGE
C
C     THIS MODULE READS THE APPLIED VOLTAGE AND THE SAMPLE
C VOLTAGE FROM THE DIGITAL VOLTMETER.  IF THE DVM IS INOPERATIVE
C THE MODULE REQUESTS THE OPERATOR TO INPUT THE  VOLTAGE READINGS
C FROM THE TERMINAL
C
C
C        AUTHOR:  CAPTAIN EDGAR A. VERCHOT,JR., USAF
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C EQPOUT
      BYTE EQUIPF(10,8)
      INTEGER IEIOF,EOFLAG(7)
C     THESE ARE THE DATA SPECIFICATIONS FOR A2
C
C  A2COM
      INTEGER NTEM,SCSET,SCOUNT,VCOUNT,RUN
      REAL TEMSET,FLDSET,VLTSET,X0
C THESE ARE THE DATA SPECIFICATIONS FOR A3
C DVMCOM
      INTEGER FUNC
      REAL TEMRD,VLTRD
C THESE ARE THE DATA SPECIFICATIONS FOR A4
C     RAWDAT
      REAL TEMDAT(20),VLTDAT(20),SVDATA(20),FLDATA(20),IDATA(20)
      INTEGER SCDATA(20)
C THESE ARE THE COMMON BLOCKS FROM MODULE A1
      COMMON /EQPOUT/EOFLAG,EQUIPF,IEIOF
C THE NAMED COMMON BLOCKS FOR A2CMN FOLLOW.
      COMMON /A2COM/TEMSET,FLDSET,VLTSET,X0,NTEM,SCSET,SCOUNT,
     2VCOUNT,RUN
C THE COMMON BLOCKS FOR A3 FOLLOW
      COMMON /DVMCOM/FUNC,TEMRD,VLTRD
C THE COMMON BLOCKS FOR A4 FOLLOW
      COMMON /RAWDAT/TEMDAT,VLTDAT,SVDATA,FLDATA,IDATA,SCDATA
C
C CHECK TO SEE IF THE DVM IS OPERATIVE
      IF(EOFLAG(2).EQ.1)GO TO 10
C READ THE APPLIED VOLTAGE
         VLTRD=DVM(1)
         VLTDAT(RUN)=VLTRD
C NOW READ THE SAMPLE VOLTAGE
         VLTRD=DVM(2)
         SVDATA(RUN)=VLTRD
         GO TO 900
10    CONTINUE
C HAVE THE OPERATOR ENTER THE REQUIRED VALUES
         WRITE(7,1000)
```

```
1000      FORMAT(' ',' ENTER THE APPLIED VOLTAGE READING ')
          READ(5,*) VLTDAT(RUN)
          WRITE(7,2000)
2000      FORMAT(' ',' ENTER THE SAMPLE VOLTAGE READING ')
          READ(5,*) SVDATA(RUN)
900    CONTINUE
       RETURN
       END
```

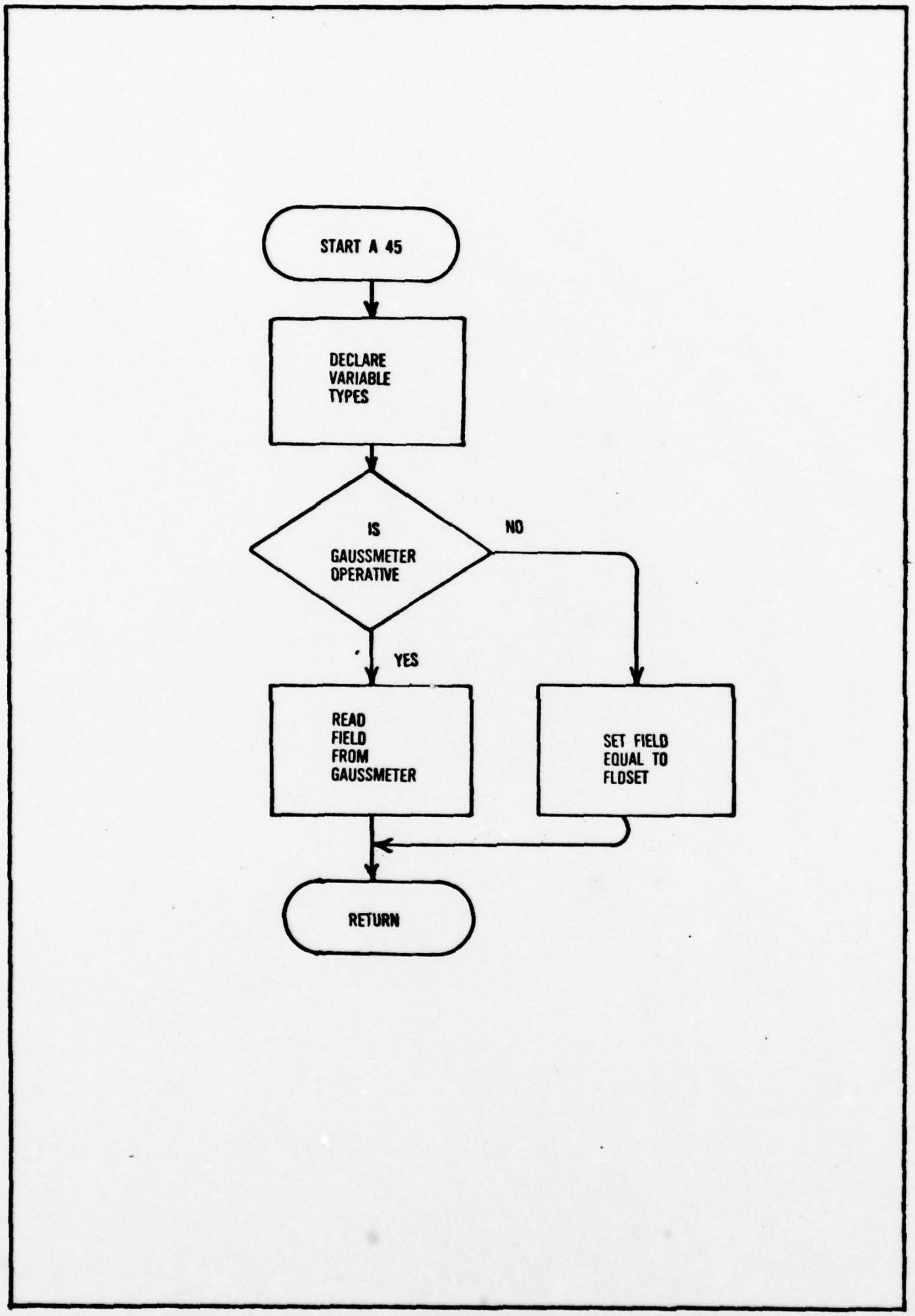


Figure 41. Flow Chart for Module A45

```
      SUBROUTINE A45
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A45---READ FIELD
C
C     THIS MODULE CALLS GAUSS TO DETERMINE THE FIELD VALUE.
C GAUSS IS A DRIVER ROUTINE FOR READING THE GAUSSMETER.  IF
C THE GAUSS METER IS INOPERATIVE THE MODULE ASSUMES THAT
C THE SETTING IS THE CORRECT VALUE.  THIS IS A LOW RISK
C ASSUMPTION BECAUSE WITHOUT THE GAUSSMETER THE FIELD WILL
C HAVE BEEN MANUALLY SET TO THE PROPER VALUE AND THE MAGNET
C IS VERY STABLE.
C
C
C          AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C DATA SPECIFICATIONS
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C EQPOUT
      BYTE EQUIPF(10,8)
      INTEGER IEIOF,EOFLAG(7)
C     THESE ARE THE DATA SPECIFICATIONS FOR A2
C
C  A2COM
      INTEGER NTEM,SCSET,SCOUNT,VCOUNT,RUN
      REAL TEMSET,FLDSET,VLTSET,X0
C THESE ARE THE DATA SPECIFICATIONS FOR A3
      INTEGER VLTAGE,MAGNET,TSTCON
C GAUSSM
      REAL FLDRD
C THESE ARE THE DATA SPECIFICATIONS FOR A4
C     RAWDAT
      REAL TEMDAT(20),VLTDAT(20),SVDATA(20),FLDATA(20),IDATA(20)
      INTEGER SCDATA(20)
C THESE ARE THE COMMON BLOCKS FROM MODULE A1
      COMMON /EQPOUT/EOFLAG,EQUIPF,IEIOF
C THE NAMED COMMON BLOCKS FOR A2CMN FOLLOW.
      COMMON /A2COM/TEMSET,FLDSET,VLTSET,X0,NTEM,SCSET,SCOUNT,
     2VCOUNT,RUN
C THE COMMON BLOCKS FOR A3 FOLLOW
      COMMON /GAUSSM/FLDRD
C THE COMMON BLOCKS FOR A4 FOLLOW
      COMMON /RAWDAT/TEMDAT,VLTDAT,SVDATA,FLDATA,IDATA,SCDATA
C
C
C CHECK TO SEE IF THE GAUSS METER IS OPERATIVE
C
C
      IF(EOFLAG(7).EQ.1) GO TO 100
         FLDRD=GAUSS(F)
         FLDATA(RUN)=FLDRD
```

```
      GO TO 900
100   CONTINUE
C     SET THE FLDATA VALUE TO EQUAL THE FIELD SETTING IF THE METER
C        IS INOPERATIVE.
C
      FLDATA(RUN)=FLDSET
900   CONTINUE
      RETURN
      END
```

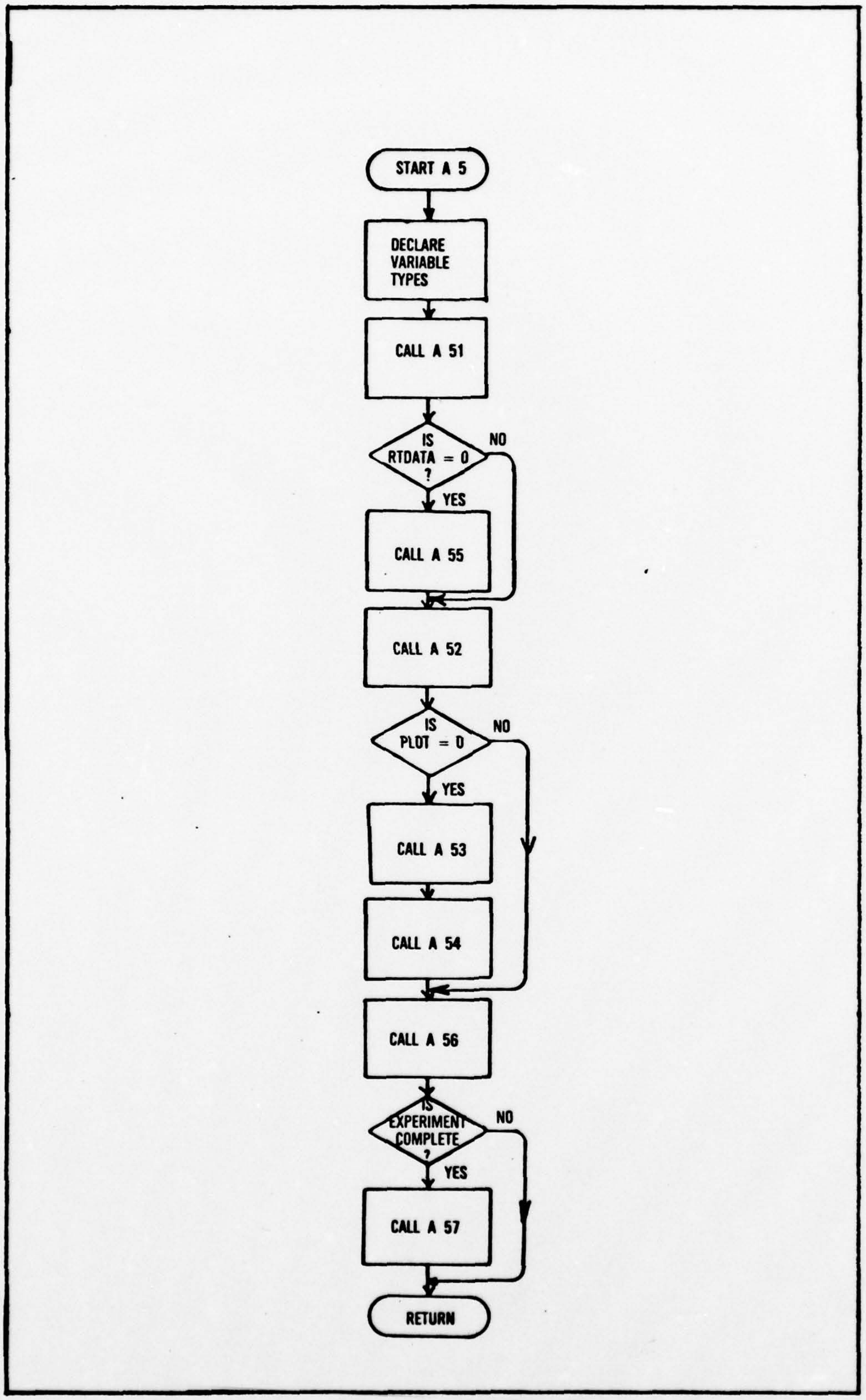


Figure 42. Flow Chart for Module A5

```
      SUBROUTINE A5
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A5---REDUCE DATA
C
C     THIS MODULE IS RESPONSIBLE FOR REDUCING ALL THE DATA
C GATHERED AND FOR WRITING IT, AND THE RESULTING PROCESSED
C DATA, TO THE DISK STORAGE AND TO THE PRINTER.  A5 IS THE EXECUTIVE
C FOR THE MODULE AND CONTROLS SEVEN OTHER MODULES.
C
C     A51---COMPUTE TEMPERATURES
C
C     A52---COMPUTE DATA OUTPUT
C
C     A53---PRINT PLOT DATA
C
C     A54---PLOT DATA
C
C     A55---PRINT REAL TIME DATA
C
C     A56---WRITE DATA ARRAYS TO DISK
C
C     A57---PRINT OUTPUT DATA ARRAY
C
C   WHEN FINISHED, THE DATA PROCESSING COMPLETE SIGNAL ALLOW THE NEXT
C BLOCK OF DATA TO BE GATHERED.
C
C
C        AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C DATA SPECIFICATIONS
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C
C HEADER
      BYTE TITLE(20),TODAY(9)
      REAL ITEMP(100)
      INTEGER TYPTEM
C DATAIN
      REAL TEMP(100),FIELD,AVLT(2,6)
      INTEGER NTEMPT,ETYPE,NAVOLT,NDATPT
C TCALIB
      BYTE THRMID(20)
      INTEGER NTEMP
      REAL TEMCAL(2,100)
C SAMPLE
      BYTE SAMID(20)
      INTEGER SAMTYP
      REAL SAMT,SAMW,SAML
C PLTOUT
      BYTE POPTS(6,11)
```

```
            INTEGER PLOTAB(4),PLOTOR(4),PLOT,NP
      C EQPOUT
            BYTE EQUIPF(10,8)
            INTEGER IEIOF,EOFLAG(7)
      C
      C RELTIM
            INTEGER RTDATA
      C
      C
      C
      C
      C     THESE ARE THE DATA SPECIFICATIONS FOR A2
      C
      C     CONSIG
            INTEGER SDP,EXPC,FSCOM,SCSCOM,VLTCOM
      C
      C  A2COM
            INTEGER NTEM,SCSET,SCOUNT,VCOUNT,RUN
            REAL TEMSET,FLDSET,VLTSET,X0
      C THESE ARE THE DATA SPECIFICATIONS FOR A3
      C THESE ARE THE DATA SPECIFICATIONS FOR A4
      C     RAWDAT
            REAL TEMDAT(20),VLTDAT(20),SVDATA(20),FLDATA(20),IDATA(20)
            INTEGER SCDATA(20)
      C THESE ARE THE DATA SPECIFICATIONS FOR A5
      C DATOUT
            REAL RHO,P,MU,RH,F
            REAL TEMOUT(20),AVGTEM,DELTA,IATEM
            REAL R(4),R1R2,R3R4,R7,R8,VHALL,RMAG
            REAL R1,R2,R12,R5,R6,DELTAR,DELR5,DELR6
            REAL E,LN2,AFIELD,PI
      C PLOTER
            REAL PLOTS(4,2)
      C THESE ARE THE COMMON BLOCKS FROM MODULE A1
      C
            COMMON /HEADER/TITLE,ITEMP,TYPTEM,TODAY
            COMMON /DATAIN/NTEMPT,TEMP,ETYPE,FIELD,
           2NAVOLT,AVLT,NDATPT
            COMMON /TCALIB/THRMID,NTEMP,TEMCAL
            COMMON /SAMPLE/SAMID,SAMTYP,SAMT,SAMW,SAML
            COMMON /PLTOUT/PLOT,POPTS,NP,PLOTAB,PLOTOR
            COMMON /EQPOUT/EOFLAG,EQUIPF,IEIOF
            COMMON /RELTIM/RTDATA
      C THE NAMED COMMON BLOCKS FOR A2CMN FOLLOW.
            COMMON /CONSIG/SDP,EXPC,FSCOM,SCSCOM,VLTCOM
            COMMON /A2COM/TEMSET,FLDSET,VLTSET,X0,NTEM,SCSET,SCOUNT,
           2VCOUNT,RUN
      C THE COMMON BLOCKS FOR A3 FOLLOW
      C THE COMMON BLOCKS FOR A4 FOLLOW
            COMMON /RAWDAT/TEMDAT,VLTDAT,SVDATA,FLDATA,IDATA,SCDATA
      C THE COMMON BLOCKS FOLLOW FOR A5
            COMMON /DATOUT/RHO,P,MU,RH,F,TEMOUT,AVGTEM,DELTA,IATEM,R,
           2R1R2,R3R4,R7,R8,VHALL,RMAG,R1,R2,R12,R5,R6,DELTAR,DELR5,DELR6,
```

```
          3E,LN2,AFIELD,PI
0040          COMMON /PLOTER/PLOTS
      C
      C FIRST COMPUTE THE TEMPERATURES FROM THE DATA VOLTAGES.
      C
      C
0041          CALL A51
      C
      C CHECK IF REAL-TIME DATA PRINTOUT IS DESIRED
      C
0042          IF(RTDATA.EQ.0) GO TO 52
0044             CALL A55(TEMOUT)
      C
0045  52      CONTINUE
      C THEN COMPUTE ALL OF THE OTHER NEEDED PARAMETERS
      C
0046          CALL A52
      C
      C CHECK IF PLOTS ARE DESIRED
      C
0047          IF(PLOT.EQ.0)GO TO 55
0049             CALL A53
0050             CALL A54
0051  55      CONTINUE
      C
      C          WRITE THE DATA BLOCK TO DISK
      C
0052          CALL A56
      C
      C CHECK IF EXPERIMENT IS COMPLETE
      C
      C IF IT IS PRINT THE OUTPUT DATA
      C
0053          IF(EXPC.EQ.0)GO TO 900
0055          CALL A57
0056  900     CONTINUE
0057          RETURN
0058          END
```

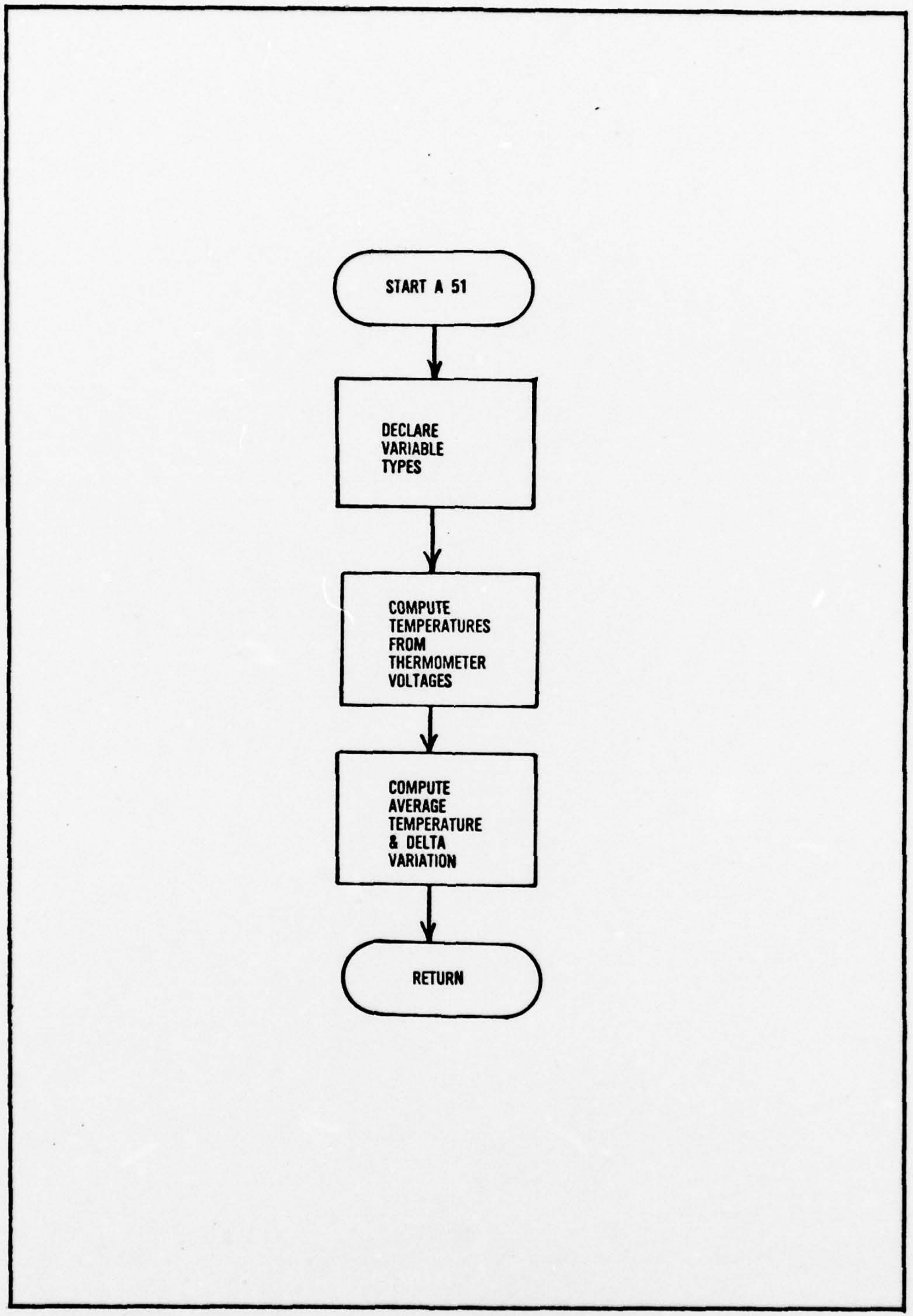


Figure 43. Flow Chart for Module A51

```
      SUBROUTINE A51
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A51---COMPUTE TEMPERATURE
C
C     THIS MODULE TAKES THE VOLTAGE RECORDED BY THE DATA ACQUISITION
C MODULE FROM THE THERMOMETER AND CONVERTS IT TO THE CORRESPONDING
C TEMPERATURES.  THE MEAN AND THE DELTA FOR THESE DATA ARE THEN COMPUTED.
C
C
C         AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C DATA SPECIFICATIONS
C
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C DATAIN
      REAL TEMP(100),FIELD,AVLT(2,6)
      INTEGER NTEMPT,ETYPE,NAVOLT,NDATPT
C TCALIB
      BYTE THRMID(20)
      INTEGER NTEMP
      REAL TEMCAL(2,100)
C THESE ARE THE DATA SPECIFICATIONS FOR A4
C     RAWDAT
      REAL TEMDAT(20),VLTDAT(20),SVDATA(20),FLDATA(20),IDATA(20)
      INTEGER SCDATA(20)
C THESE ARE THE DATA SPECIFICATIONS FOR A5
C DATOUT
      REAL RHO,P,MU,RH,F
      REAL TEMOUT(20),AVGTEM,DELTA,IATEM
      REAL R(4),R1R2,R3R4,R7,R8,VHALL,RMAG
      REAL R1,R2,R12,R5,R6,DELTAR,DELR5,DELR6
      REAL E,LN2,AFIELD,PI
C THESE ARE THE COMMON BLOCKS FROM MODULE A1
      COMMON /DATAIN/NTEMPT,TEMP,ETYPE,FIELD,
     2NAVOLT,AVLT,NDATPT
      COMMON /TCALIB/THRMID,NTEMP,TEMCAL
C THE COMMON BLOCKS FOR A4 FOLLOW
      COMMON /RAWDAT/TEMDAT,VLTDAT,SVDATA,FLDATA,IDATA,SCDATA
C THE COMMON BLOCKS FOLLOW FOR A5
      COMMON /DATOUT/RHO,P,MU,RH,F,TEMOUT,AVGTEM,DELTA,IATEM,R,
     2R1R2,R3R4,R7,R8,VHALL,RMAG,R1,R2,R12,R5,R6,DELTAR,DELR5,DELR6,
     3E,LN2,AFIELD,PI
C
C LOCAL VARIABLES
      REAL D(100),P1(100),X0,Y0,WDELTA,TEMSUM
      INTEGER NS,NF,NPT
      TEMSUM=0.0
      DELTA=0.0
C COMPUTE THE TEMPERATURE EQUIVALENT TO THE VOLTAGE READINGS FOR
```

```
C THE THERMOMETER.
         DO 10 K=1,NDATPT
           X0=TEMDAT(K)
           DO 20 N=1,NTEMP
            IF(X0.GE.TEMCAL(2,N))GO TO 30
20         CONTINUE
30         CONTINUE
            NS=N-3
            IF(NS.LT.1)NS=1
            NF=N+3
            IF(NF.GT.NTEMP)NF=NTEMP
           Y0=0.0
           DO 40 I=NS,NF
            D(I)=1.0
            P1(I)=1.0
            DO 50 J=NS,NF
               IF(I.EQ.J)GO TO 50
                    D(I)=D(I)*(TEMCAL(2,I)-TEMCAL(2,J))
                    P1(I)=P1(I)*(X0-TEMCAL(2,J))
50          CONTINUE
            Y0=Y0+(P1(I)/D(I))*TEMCAL(1,I)
40         CONTINUE
           TEMOUT(K)=Y0
C THIS PORTION OF THE PROGRAM COMPUTES THE MEAN TEMPERATURE
C FOR THE DATA BLOCK AND THE DELTA.
           TEMSUM=TEMSUM+TEMOUT(K)
10       CONTINUE
         AVGTEM=TEMSUM/NDATPT
         IATEM=1000/AVGTEM
         DO 60 I=1,NDATPT
           WDELTA=AVGTEM-TEMOUT(I)
           IF(WDELTA.GT.DELTA)DELTA=WDELTA
60       CONTINUE
         RETURN
         END
```

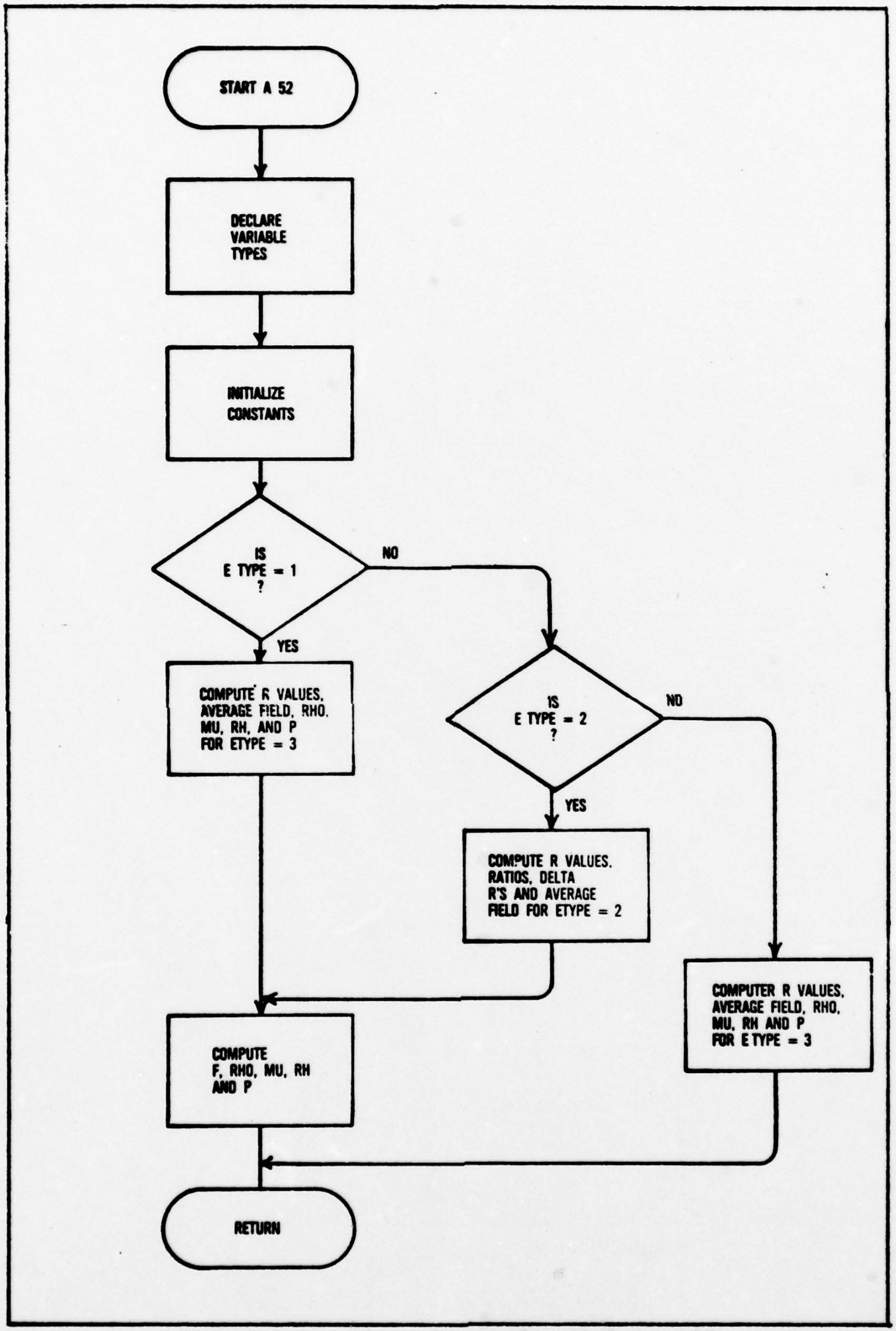


Figure 44. Flow Chart for Module A52

```
0001        SUBROUTINE A52
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C
      C MODULE A52---COMPUTE DATA OUTPUT
      C
      C     THIS MODULE COMPUTES ALL OF THE NEEDED OUTPUT DATA.  THESE
      C ARE R(1),R(2),R(3),R(4),R1/R2,R3/R4,RHO,MU,P, AND RH.
      C DEFINITIONS FOLLOW:
      C     R(1)=SV1/I1
      C     R(2)=SV2/I2
      C     R(3)=SV3/I3
      C     R(4)=SV4/I4
      C     R1/R2 AND R3/R4 ARE SELF EXPALANATORY.
      C     RHO=RESISTIVITY
      C     MU=HALL MOBILITY
      C     P=CARRIER CONCENTRATION
      C     RH=HALL COEFFICIENT
      C THESE DATA, COUPLED WITH THE TEMPERATURES FROM A51 ARE THE END RESULT
      C OF THE EXPERIMENT.
      C
      C
      C        AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
      C
      C
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C DATA SPECIFICATIONS
      C THESE ARE THE DATA SPECIFICATIONS FOR A1
      C DATAIN
0002        REAL TEMP(100),FIELD,AVLT(2,6)
0003        INTEGER NTEMPT,ETYPE,NAVOLT,NDATPT
      C SAMPLE
0004        BYTE SAMID(20)
0005        INTEGER SAMTYP
0006        REAL SAMT,SAMW,SAML
      C THESE ARE THE DATA SPECIFICATIONS FOR A2
      C A2COM
0007        INTEGER NTEM,SCSET,SCOUNT,VCOUNT,RUN
0008        REAL TEMSET,FLDSET,VLTSET,X0
      C THESE ARE THE DATA SPECIFICATIONS FOR A5
      C DATOUT
0009        REAL RHO,P,MU,RH,F
0010        REAL TEMOUT(20),AVGTEM,DELTA,IATEM
0011        REAL R(4),R1R2,R3R4,R7,R8,VHALL,RMAG
0012        REAL R1,R2,R12,R5,R6,DELTAR,DELR5,DELR6
0013        REAL E,LN2,AFIELD,PI
      C THESE ARE THE DATA SPECIFICATIONS FOR A4
      C     RAWDAT
0014        REAL TEMDAT(20),VLTDAT(20),SVDATA(20),FLDATA(20),IDATA(20)
0015        INTEGER SCDATA(20)
      C THE COMMON BLOCKS FOR A1 FOLLOW.
0016        COMMON /DATAIN/NTEMPT,TEMP,ETYPE,FIELD,
           2NAVOLT,AVLT,NDATPT
0017        COMMON /SAMPLE/SAMID,SAMTYP,SAMT,SAMW,SAML
```

```
C THE COMMON BLOCKS FOR A2 FOLLOW
        COMMON /A2COM/TEMSET,FLDSET,VLTSET,X0,NTEM,SCSET,SCOUNT,
       2VCOUNT,RUN
C THE COMMON BLOCKS FOR A4 FOLLOW
        COMMON /RAWDAT/TEMDAT,VLTDAT,SVDATA,FLDATA,IDATA,SCDATA
C THE COMMON BLOCKS FOLLOW FOR A5
        COMMON /DATOUT/RHO,P,MU,RH,F,TEMOUT,AVGTEM,DELTA,IATEM,R,
       2R1R2,R3R4,R7,R8,VHALL,RMAG,R1,R2,R12,R5,R6,DELTAR,DELR5,DELR6,
       3E,LN2,AFIELD,PI
C INITIALIZE NECESSARY PARAMETERS
        RMAG=0.0
        AFIELD=0.0
        LN2=ALOG(2.)
        E=1.6021917E-19
        PI=3.1415827
C FIRST FIND OUT THE EXPERIMENT TYPE
        IF(ETYPE.NE.1) GO TO 20
C           DO THE COMPUTATIONS FOR THE VAN DER PAUW SAMPLE TYPE
C           COMPUTE THE RESISTANCE VALUES
            DO 10 I=1,4
            R(I)=(ABS(SVDATA(2*I-1)/IDATA(2*I-1))+ABS(SVDATA(2*I)/
       2IDATA(2*I)))/2
10          CONTINUE
C           COMPUTE THE R RATIOS
            R1R2=R(1)/R(2)
            R3R4=R(3)/R(4)
C           SET THE WORKING PARAMETERS NEEDED FOR LATER CALCULATION
C           R1 IS THE AVERAGE OF R(1) AND R(3)
C           R2 IS THE AVERAGE OF R(2) AND R(4)
C           R12 IS THE RATIO OF R1/R2
            R1=(R(1)+R(3))/2
            R2=(R(2)+R(4))/2
            R12=R1/R2
C       COMPUTE DELTA R
C DELTAR IS THE AVERAGE OF DELTA R5 AND DELTA R6
            DELR5=ABS((SVDATA(13)/IDATA(13)-SVDATA(14)/IDATA(14))/4)
       2+ABS((SVDATA(17)/IDATA(17)-SVDATA(18)/IDATA(18))/4)
            DELR6=ABS((SVDATA(15)/IDATA(15)-SVDATA(16)/IDATA(16))/4)
       2+ABS((SVDATA(19)/IDATA(19)-SVDATA(20)/IDATA(20))/4)
            DELTAR=(DELR5+DELR6)/2
C       COMPUTE THE AVERAGE FIELD
            DO 11 I=13,20
               AFIELD=AFIELD+ABS(FLDATA(I))/8
11          CONTINUE
            GO TO 40
20      CONTINUE
        IF(ETYPE.NE.2) GO TO 30
C           COMPUTE THE RESISTANCE VALUES FOR ETYPE  2.
            DO 21 I=1,2
            R(I)=(ABS(SVDATA(2*I-1)/IDATA(2*I-1))+ABS(SVDATA(2*I)/
       2IDATA(2*I)))/2
21          CONTINUE
C           COMPUTE THE R RATIOS
```

```
                R1=R(1)
                R2=R(2)
                IF(SCOUNT.EQ.0)GO TO 25
                    R1R2=R(1)/R(2)
                R3R4=0.0
                    R12=R1R2
                GO TO 26
      25        CONTINUE
                R3R4=R(1)/R(2)
                R1R2=0.0
                R12=R3R4
      26        CONTINUE
      C         COMPUTE THE DELTA R
                DELTAR=ABS((SVDATA(7)/IDATA(7)-SVDATA(8)/IDATA(8))/4)
             2+ABS((SVDATA(9)/IDATA(9)-SVDATA(10)/IDATA(10))/4)
      C      COMPUTE THE AVERAGE FIELD
                DO 27 I=7,10
                AFIELD=AFIELD+ABS(FLDATA(I))/4
      27        CONTINUE
             GO TO 40
      40     CONTINUE
      C      COMPUTE THE VAN DER PAUW F VALUE
                F=1-((((R1-R2)/(R1+R2))**2)*(LN2/2.))-((((R1-R2)/(R1+R2))**4)
             2*((LN2**2/4.)-(LN2**3/12.)))
      C      NOW FIND RHO, THE RESISTIVITY
                RHO=(PI*SAMT/LN2)*((R1+R2)/2.)*F
      C      NOW FIND MU, THE HALL MOBILITY
                MU=((DELTAR*SAMT)/(RHO*AFIELD))*1.0E+5
      C      NOW FIND P, THE CARRIER CONCENTRATION
                P=1./(MU*E*RHO)
      C      NOW FIND RH, THE HALL COEFFICIENT.
                RH=MU*RHO
                GO TO 900
      30     CONTINUE
      C NOW DO THE CALCULATIONS FOR THE HALL BAR, EXPERIMENT TYPE 3
      C      FIRST FIND THE RESISTANCE
                R7=(ABS(SVDATA(1)/IDATA(1))+ABS(SVDATA(2)/IDATA(2)))/2
      C      NOW FIND RHO, THE RESISTIVITY
                RHO=SAMW*SAMT*R7/SAML
      C      FIND THE AVERAGE FIELD
                DO 31 I=5,8
                AFIELD=AFIELD+ABS(FLDATA(I))/4
      31        CONTINUE
      C      FIND V'/I'
                DO 32 I=5,8,2
                RMAG=RMAG+(SVDATA(I)/IDATA(I)-SVDATA(I+1)/IDATA(I+1))/2
      32        CONTINUE
      C      NOW FIND THE HALL MOBILITY, MU
                MU=(SAML/(AFIELD*SAMW))*(RMAG/R7)*1.0E+5
      C      NEXT FIND P, THE CARRIER CONCENTRATION
                P=AFIELD/(E*SAMT*RMAG)
      C      NOW FIND THE HALL COEFFICIENT, RH
                RH=MU*RHO
```

```
  900   CONTINUE
        RETURN
        END
```

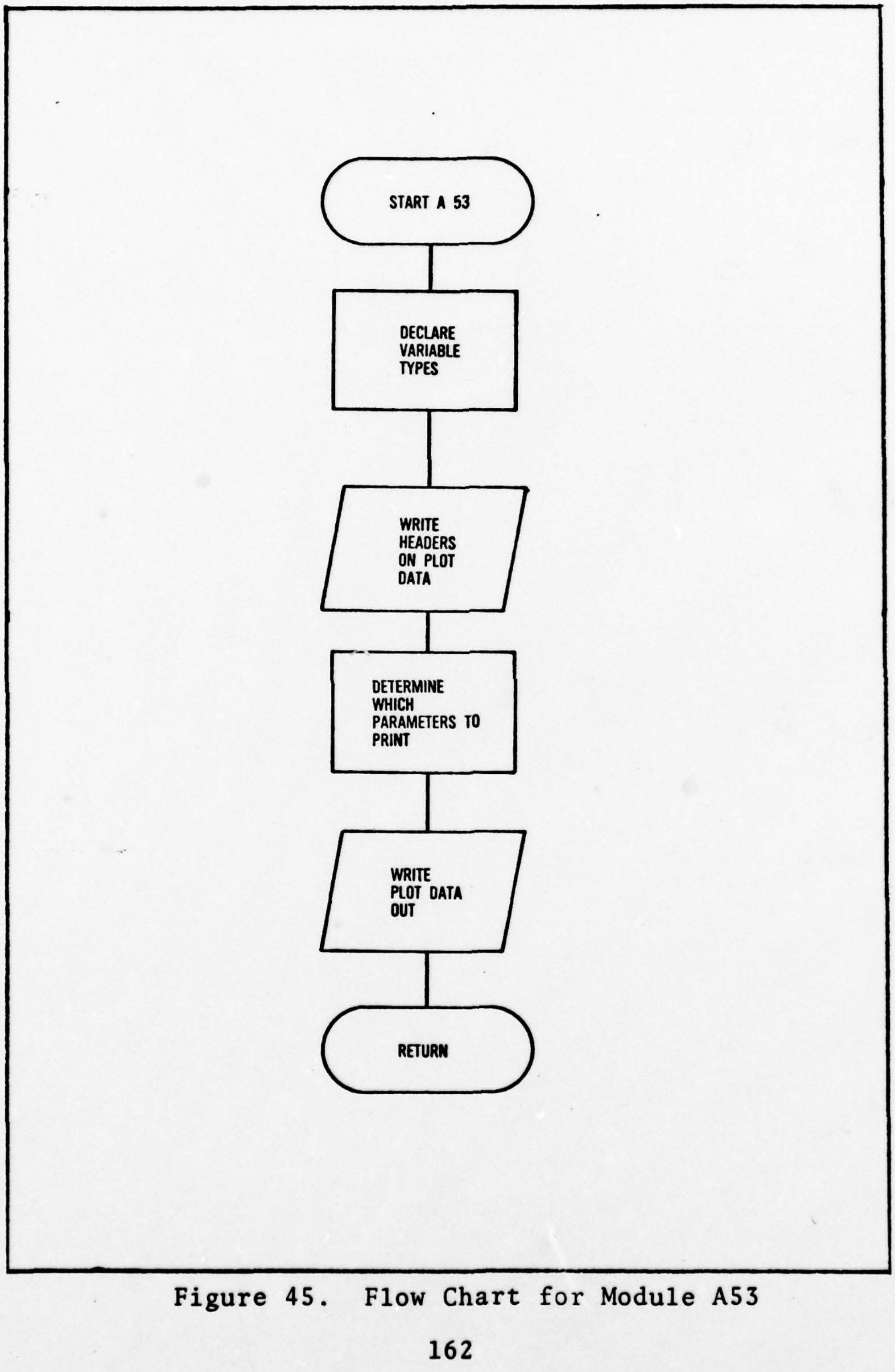


Figure 45. Flow Chart for Module A53

```
      SUBROUTINE A53
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A53---PRINT PLOT DATA
C
C     THIS MODULE PRINTS THE PLOT DATA ON THE TERMINAL
C WHENEVER THE PLOT FLAG IS SET TRUE.  IT THEM PASSES THE DATA TO
C TTHE PLOT MODULE.  IF THE PLOT FLAG IS FALSE THIS MODULE DOES
C NOT EXECUTE.
C
C         AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C DATA SPECIFICATIONS
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C PLTOUT
      BYTE POPTS(6,11)
      INTEGER PLOTAB(4),PLOTOR(4),PLOT,NP
C THESE ARE THE DATA SPECIFICATIONS FOR A5
C PLOTER
      REAL PLOTS(4,2)
C THESE ARE THE COMMON BLOCKS FROM MODULE A1
      COMMON /PLTOUT/PLOT,POPTS,NP,PLOTAB,PLOTOR
C THESE ARE THE COMMON BLOCKS FOR A5
C THESE ARE THE DATA SPECIFICATIONS FOR A5
C DATOUT
      REAL RHO,P,MU,RH,F
      REAL TEMOUT(20),AVGTEM,DELTA,IATEM
      REAL R(4),R1R2,R3R4,R7,R8,VHALL,RMAG
      REAL R1,R2,R12,R5,R6,DELTAR,DELR5,DELR6
      REAL E,LN2,AFIELD,PI
C THESE ARE THE DATA SPECIFICATIONS FOR A4
C     RAWDAT
      REAL TEMDAT(20),VLTDAT(20),SVDATA(20),FLDATA(20),IDATA(20)
      INTEGER SCDATA(20)
C THE COMMON BLOCKS FOR A4 FOLLOW
      COMMON /RAWDAT/TEMDAT,VLTDAT,SVDATA,FLDATA,IDATA,SCDATA
C THE COMMON BLOCKS FOLLOW FOR A5
      COMMON /DATOUT/RHO,P,MU,RH,F,TEMOUT,AVGTEM,DELTA,IATEM,R,
     2R1R2,R3R4,R7,R8,VHALL,RMAG,R1,R2,R12,R5,R6,DELTAR,DELR5,DELR6,
     3E,LN2,AFIELD,PI
      COMMON /PLOTER/PLOTS
C LOCAL VARIABLES
      INTEGER HOLD(2)
C   NOW PRINT THE DESIRED DATA
      DO 1 I=1,NP
         WRITE(7,1000) (POPTS(L,PLOTAB(I)),L=1,6),
     2(POPTS(K,PLOTOR(I)),K=1,6)
1000     FORMAT(1X,6A1,7X,6A1)
         HOLD(1)=PLOTAB(I)
         HOLD(2)=PLOTOR(I)
         DO 200 J=1,2
            K=HOLD(J)
```

```
                GO TO (10,20,30,40,50,60,70,80,90,100),K
                   WRITE(7,800)
      800          FORMAT(// ERROR IN THE PLOT MODULE/)
                   GO TO 900
      10        CONTINUE
                   PLOTS(I,J)=AVGTEM
                   GO TO 200
      20        CONTINUE
                   PLOTS(I,J)=IATEM
                   GO TO 200
      30        CONTINUE
                   PLOTS(I,J)=RHO
                   GO TO 200
      40        CONTINUE
                   PLOTS(I,J)=MU
                   GO TO 200
      50        CONTINUE
                   PLOTS(I,J)=P
                   GO TO 200
      60        CONTINUE
                   PLOTS(I,J)=DELTA
                   GO TO 200
      70        CONTINUE
                   PLOTS(I,J)=R1R2
                   GO TO 200
      80        CONTINUE
                   PLOTS(I,J)=R3R4
                   GO TO 200
      90        CONTINUE
                   PLOTS(I,J)=RH
                   GO TO 200
      100       CONTINUE
                   PLOTS(I,J)=R12
      200       CONTINUE
                   WRITE(7,2000)(PLOTS(I,J),J=1,2)
      2000            FORMAT(1X,G15.8,3X,G15.8)
      1     CONTINUE
      C CALL THE PLOTTER
               CALL A54
      900   CONTINUE
               RETURN
               END
```

```
0001        SUBROUTINE A54
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C
      C MODULE A54---PLOT DATA
      C
      C NO PLOTTER HAS YET BEEN PURCHASED.  THE APPROPRIATE DRIVER FOR IT
      C WILL BE ENTERED HERE WHEN IT IS.
      C
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
0002        RETURN
0003        END
```

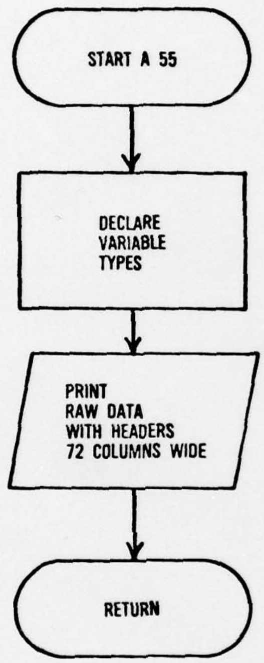


Figure 46. Flow Chart for Module A55

```
      SUBROUTINE A55(TEMOUT)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A55---PRINT REAL-TIME DATA
C
C     THIS MODULE TAKES THE RAW DATA AND IF THE RTDATA FLAG IS SET
C TRUE, PRINTS IT OUT TO THE TEEMINAL AFTER EACH BLOCK OF DATA
C IS GATHERED.
C
C         AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C DATA SPECIFICATIONS
C
C
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C
C HEADER
      BYTE TITLE(20),TODAY(9)
      REAL ITEMP(100)
      INTEGER TYPTEM
C TCALIB
      BYTE THRMID(20)
      INTEGER NTEMP
      REAL TEMCAL(2,100)
C SAMPLE
      BYTE SAMID(20)
      INTEGER SAMTYP
      REAL SAMT,SAMW,SAML
C     THESE ARE THE DATA SPECIFICATIONS FOR A2
C  A2COM
      INTEGER NTEM,SCSET,SCOUNT,VCOUNT,RUN
      REAL TEMSET,FLDSET,VLTSET,X0
C THESE ARE THE COMMON BLOCKS FROM MODULE A1
C
      COMMON /HEADER/TITLE,ITEMP,TYPTEM,TODAY
      COMMON /TCALIB/THRMID,NTEMP,TEMCAL
      COMMON /SAMPLE/SAMID,SAMTYP,SAMT,SAMW,SAML
C THE NAMED COMMON BLOCKS FOR A2CMN FOLLOW.
      COMMON /A2COM/TEMSET,FLDSET,VLTSET,X0,NTEM,SCSET,SCOUNT,
     2VCOUNT,RUN
C THESE ARE THE DATA SPECIFICATIONS FOR A4 COMMON
C     RAWDAT
      REAL TEMDAT(20),VLTDAT(20),SVDATA(20),FLDATA(20),IDATA(20)
      INTEGER SCDATA(20)
C THE COMMON BLOCKS FOR A4 FOLLOW
      COMMON /RAWDAT/TEMDAT,VLTDAT,SVDATA,FLDATA,IDATA,SCDATA
C
      REAL TEMOUT(20)
C
C
C PRINT THE DATA 72 COLUMNS WIDE
      IF(NTEM.NE.2) GO TO 100
```

```
        WRITE(7,1000)(TODAY(I),I=1,9),(TITLE(J),J=1,19)
1000    FORMAT(' ',' DATE:  ',9A1,/,' TITLE:  ',19A1)
        WRITE(7,1010)(THRMID(K),K=1,19),(SAMID(L),L=1,19)
1010    FORMAT(' ','THERMOMETER IDENTIFIER:  ',/,20A1,/,
     2  ' SAMPLE IDENTIFIER:  ',20A1)
        IF(SAMTYP.NE.0)GO TO 110
        WRITE(7,1100) SAMT
1100        FORMAT(' ',' SAMPLE DIMENSIONS ARE:  ',/,
     2      ' THICKNESS= ',G13.7,' CENTIMETERS')
        GO TO 100
110     CONTINUE
        WRITE(7,1110) SAMT,SAMW,SAML
1110    FORMAT(' ',' SAMPLE DIMENSIONS ARE:  ',/,
     2      ' SAMPLE THICKNESS= ',G13.7,' CENTIMETERS',/,
     3  ' SAMPLE WIDTH= ',G13.7,' CENTIMETERS',/,
     4      ' SAMPLE LENGTH= ',G13.7,' CENTIMETERS')
100   CONTINUE
        WRITE(7,2000)
2000  FORMAT(' ',' TEMPERATURE ','  APPLIED   ','   SAMPLE   ',
     2'   FIELD    ','   SAMPLE   ','  CURRENT   ',/,
     315X,' VOLTAGE   ','   VOLTAGE  ',12X,'CONFIGURATION',/,
     4'  (DEGREE K) ','   (VOLTS)   ','   (VOLTS)   ',' (KGAUSS) ',
     512X,'   (AMPERES)  ',/)
      DO 200 I=1,RUN
        WRITE(7,2010) TEMOUT(I),VLTDAT(I),SVDATA(I),FLDATA(I),
     2SCDATA(I),IDATA(I)
2010    FORMAT(' ',1X,G12.5,3G12.5,5X,I2,5X,G14.7)
200   CONTINUE
      RETURN
      END
```

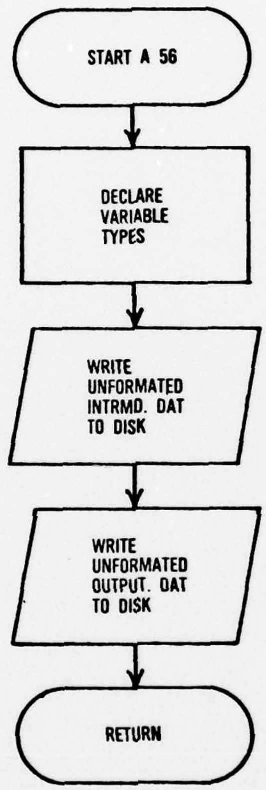


Figure 47. Flow Chart for Module A56

```
      SUBROUTINE A56
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A56---WRITE DATA ARRAYS TO THE DISK FILES
C
C     THIS MODULE TAKES THE RAW DATA AND THE PROCESSED DATA AND
C WRITES IT TO THE DISK STORAGE USING UNFORMATTED WRITE STATEMENTS.
C IT CAN BE RECALLED USING UNFORMATTED READ STATEMENTS.  THREE FILES
C ARE USED:
C    1.  RAWOUT.DAT
C    2.  INTRMD.DAT
C    3.  OUTPUT.DAT
C THESE FILES MUST NOT EXIST ON THE STORAGE DISK PRIOR TO BEING
C CREATED BY THIS PROGRAM.  IF THEY EXIST THEY MUST BE DELETED OR
C A FRESH DISK SUBSTITUTED.  WHEN FINISHED THE MODULE RETURNS
C UNLESS THE EXPERIEMENT COMPLETE FLAG IS SET TRUE.  IF IT IS
C CONTROL PASSED TO A57.
C
C         AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C DATA SPECIFICATIONS
C     THESE ARE THE DATA SPECIFICATIONS FOR A2
C  A2COM
      INTEGER NTEM,SCSET,SCOUNT,VCOUNT,RUN
      REAL TEMSET,FLDSET,VLTSET,X0
C THESE ARE THE DATA SPECIFICATIONS FOR A4 COMMON
C     RAWDAT
      REAL TEMDAT(20),VLTDAT(20),SVDATA(20),FLDATA(20),IDATA(20)
      INTEGER SCDATA(20)
C THESE ARE THE DATA SPECIFICATIONS FOR A5
C DATOUT
      REAL RHO,P,MU,RH,F
      REAL TEMOUT(20),AVGTEM,DELTA,IATEM
      REAL R(4),R1R2,R3R4,R7,R8,VHALL,RMAG
      REAL R1,R2,R12,R5,R6,DELTAR,DELR5,DELR6
      REAL E,LN2,AFIELD,PI
C THE COMMON BLOCKS FOR A4 FOLLOW
      COMMON /RAWDAT/TEMDAT,VLTDAT,SVDATA,FLDATA,IDATA,SCDATA
C THE COMMON BLOCKS FOLLOW FOR A5
      COMMON /DATOUT/RHO,P,MU,RH,F,TEMOUT,AVGTEM,DELTA,IATEM,R,
     2R1R2,R3R4,R7,R8,VHALL,RMAG,R1,R2,R12,R5,R6,DELTAR,DELR5,DELR6,
     3E,LN2,AFIELD,PI
C THE NAMED COMMON BLOCKS FOR A2CMN FOLLOW.
      COMMON /A2COM/TEMSET,FLDSET,VLTSET,X0,NTEM,SCSET,SCOUNT,
     2VCOUNT,RUN
C
C
C WRITE RAWOUT.DAT
      DO 10 I=1,RUN
         WRITE(1) TEMOUT(I),VLTDAT(I),SVDATA(I),FLDATA(I),
     2            SCDATA(I),IDATA(I)
```

```
10    CONTINUE
C     WRITE INTRMD.DAT
      WRITE(2) AVGTEM,DELTA,R1R2,R3R4,R12
      IUNIT=ILUN(3)
C WRITE OUTPUT DATA
      WRITE(3) AVGTEM,IATEM,RHO,MU,P,RH
      I=IWAIT(IUNIT)
      RETURN
      END
```

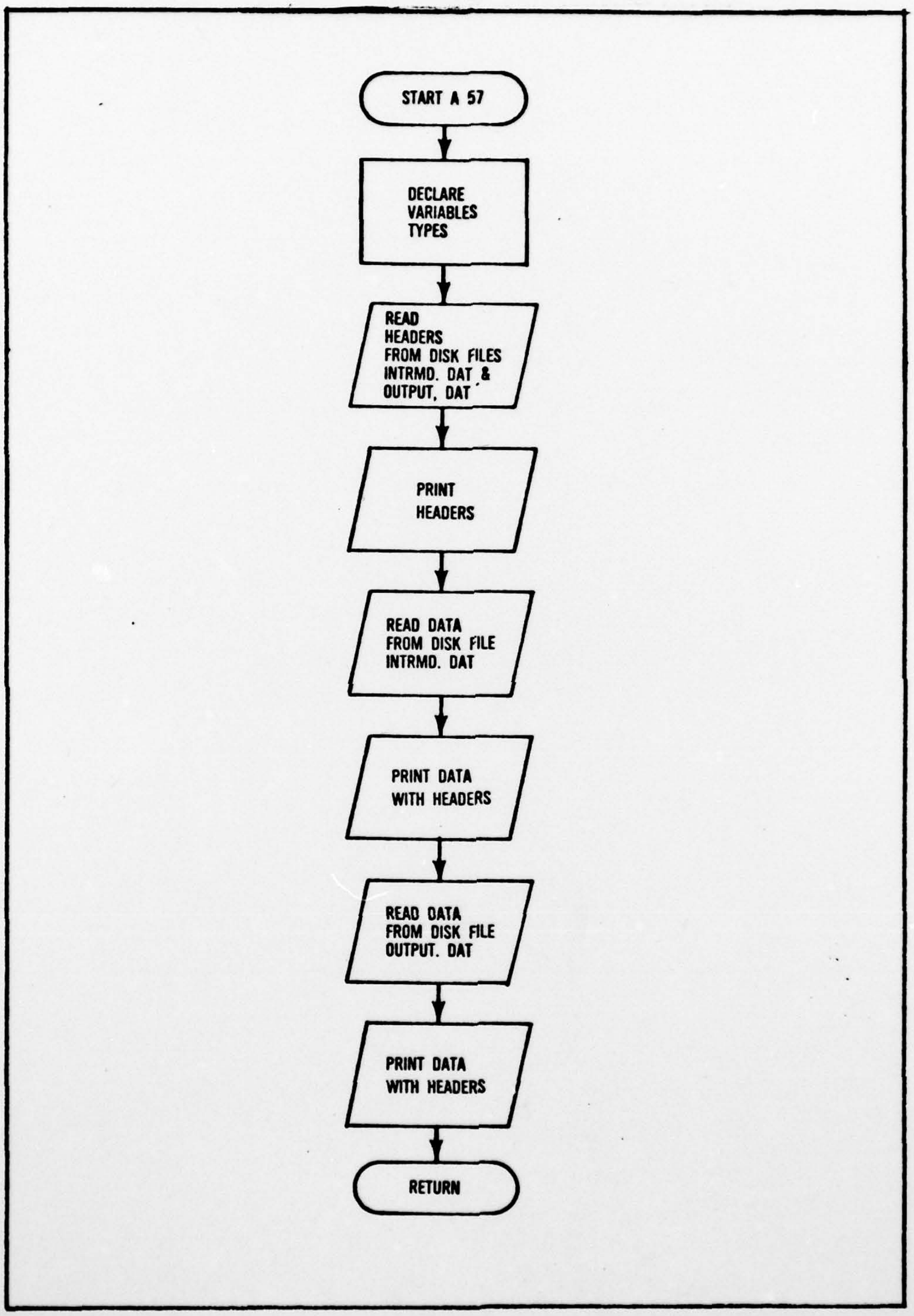


Figure 48. Flow Chart for Module A57

```
      SUBROUTINE A57
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C MODULE A57---PRINT OUTPUT DATA ARRAYS
C
C     THIS MODULE OUTPUTS THE CONTENTS OF THE TWO PROCESSED
C DATA ARRAY FILES:
C     INTRMD.DAT AND
C     OUTPUT.DAT
C WHEN THE EXPERIMENT IS COMPLETE.
C
C
C          AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C DATA SPECIFICATIONS
C LOCAL VARIABLES
C
      BYTE TODAY(9),TITLE(20),THRMID(20),SAMID(20)
      INTEGER SAMTYP
      REAL SAMT,SAMW,SAML
C THESE ARE THE DATA SPECIFICATIONS FROM MODULE A1
C EQPOUT
      BYTE EQUIPF(10,8)
      INTEGER IEIOF,EOFLAG(7)
C     THESE ARE THE DATA SPECIFICATIONS FOR A2
C  A2COM
      INTEGER NTEM,SCSET,SCOUNT,VCOUNT,RUN
      REAL TEMSET,FLDSET,VLTSET,X0
C THESE ARE THE COMMON BLOCKS FROM MODULE A1
      COMMON /EQPOUT/EOFLAG,EQUIPF,IEIOF
C THE NAMED COMMON BLOCKS FOR A2CMN FOLLOW.
      COMMON /A2COM/TEMSET,FLDSET,VLTSET,X0,NTEM,SCSET,SCOUNT,
     2VCOUNT,RUN
C
C
C REWIND THE FILES
      REWIND 2
      REWIND 3
C READ THE HEADER INFORMATION AND PRINT IT OUT
      DO 10 I=2,3
         READ(I) (TODAY(J),J=1,9)
         READ(I) (TITLE(K),K=1,19)
         READ(I) (THRMID(L),L=1,19)
         READ(I) (SAMID(M),M=1,20)
         READ(I) SAMTYP
         IF (SAMTYP.NE.0) GO TO 100
          READ(I) SAMT
          GO TO 11
100      CONTINUE
         READ(I) SAMT,SAMW,SAML
```

```
11          CONTINUE
C THROW AWAY THE REDUNDANT INFORMATION
            IF(I.NE.2) GO TO 10
            WRITE(7,1000)(TODAY(J),J=1,9),(TITLE(K),K=1,19),
     2          (THRMID(L),L=1,19),(SAMID(M),M=1,19)
1000            FORMAT(' ',1X,9A1,/,1X,19A1,/,1X,19A1,/,1X,19A1,/)
            IF(SAMTYP.NE.0) GO TO 200
                WRITE(7,1100) SAMT
1100            FORMAT(' ',' SAMPLE THICKNESS = ',G14.7,
     2              'CENTIMETERS')
                GO TO 10
200         CONTINUE
                WRITE(7,2000) SAMT,SAMW,SAML
2000            FORMAT(' ',' SAMPLE THICKNESS = ',G14.7,
     2          'CENTIMETERS',/,' SAMPLE WIDTH = ',G14.7,
     3          'CENTIMETERS',/,' SAMPLE LENGTH = ', G14.7,
     4          'CENTIMETERS')
10      CONTINUE
        IF(IEIOF.EQ.0) GO TO 21
        WRITE(7,1900)
1900    FORMAT(' ',' THE FOLLOWING AUTOMATIC EQUIPMENT WAS
     2 INOPERATIVE:')
        DO 20 I=1,7
            IF(EOFLAG(I).NE.1) GO TO 20
            WRITE(7,2020) (EQUIPF(J,I),J=1,10)
2020        FORMAT(' ',10A1,///)
20      CONTINUE
21      CONTINUE
C
C PRINT THE INTERMEDIATE ARRAY
        WRITE(7,3000)
3000    FORMAT(' ',' TEMPERATURE ','   DELTA    ',
     2'   R1/R2     ','   R3/R4     ',' AVG R1/R2  ')
        DO 30 I=1,100
            READ(2,END=35) A,D,R1,R3,R12
            WRITE(7,3030) A,D,R1,R3,R12
3030        FORMAT(' ',1X,5G12.5)
30      CONTINUE
35      CONTINUE
C   NOW PRINT THE OUTPUT DATA ARRAY
        WRITE(7,4000)
4000    FORMAT(' ',' TEMPERATURE ','    1/T     ',
     2' RESISTIVITY ','    HALL    ','  CARRIER   ',
     3'    HALL    ',/,36X,'     MOBILITY  ','CONCENTRATION',
     4' COEFFICIENT')
        DO 40 I=1,100
            READ(3,END=45) A,T,R,U,P,RH
            WRITE(7,4040) A,T,R,U,P,RH
4040        FORMAT(' ',1X,6G12.5)
40      CONTINUE
45      CONTINUE
        CLOSE(UNIT=1)
        CLOSE(UNIT=2)
```

```
      CLOSE(UNIT=3)
      RETURN
      END
```

```
      FUNCTION GAUSS(IOVLD)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C THIS IS THE GAUSS METER DRIVER PROVIDED BY MR. DANE HANBY, UDRI.  THE
C  GAUSSMETER MUST BE SET TO THE 10K GAUSS SCALE FOR THE VALUE TO BE
C CORRECT.  THERE IS NO AUTOMATED CONTROL OF THE METER.  IT SIMPLY PASSES
C THE DATA OUT.  FURTHERMORE IT DOES NOT PASS OUT THE SCALE THAT IT
C IS SET TO.  THEREFORE IT MUST BE MANUALLY SET TO THE 10K GAUSS SCALE)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      INTEGER CRS1,OUT1,IN1
      DATA CRS1/"167770/,OUT1/"167772/,IN1/"167774/
      IOVLD=0
   10 IWORD=IPEEK(IN1)
      IF((IWORD .AND. "20000) .EQ. 0) GOTO 10
      IF((IWORD .AND. "40000) .NE. 0) IOVLD=1
      IVAL=IBCD(IWORD .AND. "17777)
      IF((IWORD .AND. "100000 ).NE. 0)IVAL=-IVAL
      GAUSS=0.1*IVAL
      RETURN
      END
```

```
      INTEGER FUNCTION TSTCON(ISAM,IPOL)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CC
C THIS MODULE CONTROLS THE SAMPLE CONFIGURATION SETTING VIA THE UDRI
C TEST CONTROLLER.  THIS DRIVER MODULE WAS WRITTEN BY MR. DANE HANBY, UDRI.
C IT SIMPLY SETS THE SAMPLE CONFIGURATION AND POLARITY TO THOSE SPECIFIED
C AND PASSES A TST SAMPLE OK SIGNAL BACK TO THE CALLING PROGRAM
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      INTEGER CRS1,OUT1,IN1
      DATA CRS1/"167770/,OUT1/"167772/,IN1/"167774/
      ICONF=ISAM-1
      IREG=IPEEK(OUT1) .AND. "170377
      IOUT=IREG .OR. (IPOL * 2048 + ICONF * 256)
      CALL IPOKE(OUT1,IOUT)
      TSTCON=1
      RETURN
      END
```

```
      FUNCTION DMM(IDATA)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C THIS MODULE CALLS THE KEITHLEY MODEL 616 DIGITAL ELECTROMETER
C TO READ THE CURRENT DATA.  THIS IS DONE BY CALLING THE DRIVER
C SUBPROGRAM SUPPLIED BY UDRI, IDMMC1, IDMMGT, AND FLOAT.  IDMMGT
C READS THE CURRENT VALUE FORM THE DMM INTO THE IDATA ARRAY.  THIS
C VALUE IS THEN TRANSFORMED INTO A FLOATING POINT NUMBER USING THE
C IDMMC1, AND FLOAT.
C
C
C        AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C DATA SPECIFICATIONS
      INTEGER IDATA(9)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C THIS PROGRAM WAS ORIGINALLY WRITTEN BY FRANK BEITAL OF UDRI.  IT WAS
C MODIFIED BY CAPTAIN VERCHOT FOR USE WITH HIS AHEDAS SYSTEM.
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C     READ THE KEITHLEY ELECTROMETER
1     CONTINUE
      L=IDMMGT(IDATA)
C     NOW DECODE THE IDATA ARRAY PASSED FROM THE KEITHLEY
      MANTIS = IDMMC1 (IDATA(1),4)
      IFUNC = IDATA(5)/4
      IEXP=IDMMC1(IDATA(5),2)
      IDP=IDATA(1)/8 .OR. 2*IDATA(8)
      IF(IDP.EQ.-2)GO TO 10
      ISCALE = -128
      IF (IDP.EQ. 1) ISCALE = -2
      IF (IDP.EQ. 2) ISCALE = -1
      IF (IDP.EQ. 4) ISCALE =  0
      IF (IDP.EQ. 8) ISCALE =  1
      IF (IDP.EQ.16) ISCALE =  2
D     WRITE(5,1000) MANTIS,IEXP,ISCALE,IFUNC,IDP
D1000 FORMAT(' ', I5,'*10**',I3,' SCL',I4,' F',I4,' DP',O8)
      IEXP1 = IEXP + ISCALE - 3
      DMM = FLOAT(MANTIS)*10.0**IEXP1
      GO TO 900
C CHECK TO SEE IF THE DMM NEEDS TO HAVE THE SCALE CHANGED
10    CONTINUE
         WRITE(7,100) IEXP+2
100      FORMAT(' SET THE KEITHLEY ELECTROMETER TO THE 10 TO THE ',I3,
     2         'SCALE'/' CARRIAGE RETURN WHEN SET',$)
         PAUSE
         GO TO 1
900   CONTINUE
      RETURN
      END
```

```
      FUNCTION IDMMC1 (IDIG,LEN)
      INTEGER IDIG(LEN)
C
C
      ISIGN = IDIG(1).AND.2
      IDMMC1 = IDIG(1).AND.1
C
      DO 10 I = 2,LEN
        IDMMC1 = 10*IDMMC1 + IDIG(I)
10    CONTINUE
C
      IF (ISIGN.EQ.0) IDMMC1=-IDMMC1
C
      RETURN
      END
```

```
      INTEGER FUNCTION MAGNET(FLDSET,FLD)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C THIS MODULE WILL SET THE MAGNET TO THE DESIRED FIELD VALUE.
C IT TAKES THE FIELD SETTING AND COMPUTES THE REQUIRED NUMBER
C OF STEPS AND SETS THEM. IT THEN CHECKS THE GAUSS METER AND MAKES ANY
C MORE REQUIRED ADJUSTMENTS.  THIS DRIVER INCORPORATED THE DRIVER
C SUBROUTINES WRITTEN BY DANE HANBY OF UDRI.
C
C
C        AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C DATA SPECIFICATIONS
C EQPOUT
      BYTE EQUIPF(10,8)
      INTEGER IEIOF,EOFLAG(7)
      COMMON /EQPOUT/EOFLAG,EQUIPF,IEIOF
      INTEGER CRS1,OUT1,IN1,IN2
      DATA CRS1/"167770/,OUT1/"167772/,IN1/"167774/,IN2/"167764/
C CHECK TO SEE IF THE MAGNET CONTROLLER IS INOPERATIVE
      IF(EOFLAG(5).NE.0)GO TO 800
      FLDMAG=ABS(FLDSET)-ABS(FLD)
C DETERMINE THE POLARITY TO WHICH THE MAGNET MUST BE SET.
      IF(FLDSET.EQ.0.0) GO TO 3
      IF(FLDSET.GT.0.0) GO TO 2
        IREV=1
        GO TO 3
2     CONTINUE
        IREV=0
3     CONTINUE
C SET THE POLARITY OF THE MAGNETIC FIELD.
      ISIGN=IPEEK(OUT1).AND.16384
      IF(ISIGN.EQ.IREV) GO TO 49
        IREG=IPEEK(OUT1).AND."137777
        IOUT=IREG.OR.(IREV*16384)
        CALL IPOKE(OUT1,IOUT)
49    CONTINUE
C NOW CALCULATE THE NUMBER OF STEPS REQUIRED TO SET THE FIELD TO THE
C DESIRED SETTING.  USING THE FOUR TO ONE RATIO PULLEY, THE PARAMETERS ARE:
C  180 STEPS/SHAFT REVOLUTION, AT 4:1---720 STEPS/KGAUSS, 100 STEPS/SEC RATE.
C EXPERIMENTAL TESTING REVEALED THAT 720 STEPS WAS INCORRECT; THE
C CORRECT VALUE IS 738.46 STEPS/KGAUSS.
          NSTEPS=ABS(FLDMAG)*738.46
C     FIND THE DIRECTION OF TRAVEL TO THE STEPPER MOTOR
        IDIR=2
        IF(FLDMAG.GT.0.0)IDIR=1
      IOUT=IASH(IDIR,12,IDUM)
      J=IQSET(2)
C     MOVE THE STEPPER MOTOR AS REQUIRED
50    CONTINUE
```

AD-A080 175 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOO--ETC F/G 9/2
AUTOMATED HALL EFFECT EXPERIMENT DATA ACQUISITION SYSTEM (AHEED--ETC(U)
DEC 79 E A VERCHOT
UNCLASSIFIED AFIT/GEO/EE/79D-5 NL

3 OF 3
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A080175

END
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3 - 80
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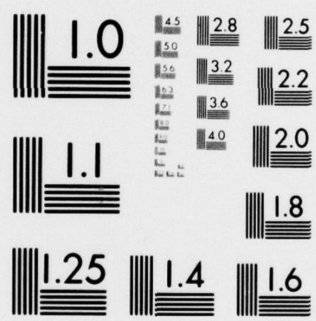

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

```
            DO 10 I=1,NSTEPS
                 CALL IBISA(IOUT,OUT1)
                 CALL IBICA(IOUT,OUT1)
             K=ISLEEP(0,0,0,1)
 10         CONTINUE
 C        NOW CHECK THE MAGNET OUTPUT FOR STABILITY
 20       CONTINUE
             IF((IPEEK(IN2).AND."2).EQ.0)GO TO 30
             IF((IPEEK(IN2).AND."1).EQ.0)GO TO 30
             GO TO 40
 30       CONTINUE
             M=ISLEEP(0,0,1,0)
             GO TO 20
 40       CONTINUE
 C NOW CHECK THE GAUSSMETER
             IF(EOFLAG(7).NE.0)GO TO 60
                 DFIELD=ABS(FLDSET)-ABS(GAUSS(IOULD))
                 IF(ABS(DFIELD).LE.0.01)GO TO 60
                 NSTEPS=ABS(DFIELD)*738.46
                 IDIR=2
                 IF(DFIELD.GT.0.0)IDIR=1
                 GO TO 50
 60          CONTINUE
             MAGNET=1
          GO TO 900
 C GET OPERATOR TO SET MAGNET MANUALLY BECAUSE MAGNET CONTROLLER INOP
 800      CONTINUE
          WRITE(7,8000) FLDSET
 8000     FORMAT(' PLEASE SET THE MAGNET TO',G14.7,' KGAUSS'/
      2         ' ENTER AN INTEGER WHEN VALUE IS SET AND STABLE',$)
          READ(5,*) INT
          MAGNET=1
 900         CONTINUE
          FLD=FLDSET
          RETURN
          END
```

```
      FUNCTION DVM(IFUNC)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C THIS MODULE CALLS THE SCANNER AND THE DIGITAL VOLTMETER BY
C CALLING THE GPIB, IEEE 488-1975 INTERFACE PROGRAM.  THE NECESSARY
C COMMAND STRINGS ARE LOADED INTO BYTE ARRAYS AND PASSED TO
C THE INSTRUMENT VIA THE GPIBU1MAC SUBPROGRAM.  THE DETAILS
C OF THE CONTROL OPTIONS ARE SET OUT IN THE MANUALS OF THESE
C THREE INSTRUMENTS: HP SCANNER, HP DIGITAL VOLTMETER,AND THE
C NATIONAL INSTRUMENTS GPIB INTERFACE.  THE SEQUENCE OF EVENTS
C IS AS FOLLOWS:
C      THE PROGRAM CALLS THE GPIB AND PASSES TO IT THE COMMAND
C      ARRAY FOR THE SCANNER.
C       THE SCANNER IS DIRECTED TO CLOSE ONE PARTICULAR CHANNEL.
C       THE GPIB IS THEN CALLED AGAIN TO PASS A COMMAND ARRAY TO
C      THE DIGITAL VOLTMETER WHICH CAUSES THE DATA TO BE READ FROM
C      IT INTO THE PROGRAM. THERE IT IS DECODED FROM THE ASCII CODE
C      AND PUT INTO A REAL FLOATING POINT VARIABLE.
C
C THIS IS DONE EACH TIME THE VOLT METER IS NEEDED TO MAKE A READING.
C THE DVM IS THEN RESET TO READ THE THERMOMETER VOLTAGE CONTINUOUSLY.
C
C
C          AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C DATA SPECIFICATIONS
C
      BYTE MPX0(3),MPX1(3),MPX2(3),DVMCOM(14),VALUE(15),DVMON(4)
      INTEGER ERRET
      DATA MPX0/'0','0','E'/
      DATA MPX1/'0','1','E'/
      DATA MPX2/'0','2','E'/
      DATA DVMCOM/'F','1','R','7','T','1','M','3','A',
     2'0','H','0','D','0'/
      DATA DVMON/'T','3','T','3'/
      ICOUNT=0
1     CONTINUE
      ASSIGN 1 TO ERRET
C INITIALIZE THE DIGITAL VOLTMETER
      IF(IFUNC.NE.0) GO TO 10
         I=IBUP(0,3,DVMCOM,14)
         IF(I.NE.0)GO TO 800
         GO TO 900
10    CONTINUE
      ASSIGN 10 TO ERRET
C     READ THE APPLIED VOLTAGE
11    CONTINUE
      ASSIGN 11 TO ERRET
         IF(IFUNC.NE.1)GO TO 20
C     FIRST SET THE MULTIPLEX SCANNER(HP3495A) TO SELECT THE PROPER CHANNEL
```

```
            J=IBUP(0,2,MPX0,3)
            IF(J.NE.0)GO TO 810
C      NOW READ THE DVM DATA
            K1=IBUP(0,3,DVMON,4)
            K=IBUP(1,3,VALUE,15)
            K2=IBUP(2,3)
C      DECODE THE DVM OUTPUT
            DECODE(13,100,VALUE) DVM
100         FORMAT(E13.7)
            GO TO 900
20     CONTINUE
       ASSIGN 20 TO ERRET
C      READ THE SAMPLE VOLTAGE
            IF(IFUNC.NE.2)GO TO 30
C           FIRST SET UP THE HP3495A TO THE PROPER CHANNEL
            L=IBUP(0,2,MPX1,3)
            IF(L.NE.0)GO TO 810
C      NOW READ THE DVM
            L1=IBUP(0,3,DVMON,4)
            L=IBUP(1,3,VALUE,15)
            L2=IBUP(2,3)
C           DECODE THE DVM DATA OUTPUT
            DECODE(13,100,VALUE) DVM
            GO TO 900
30     CONTINUE
       ASSIGN 30 TO ERRET
C      READ THE TEMPERATURE FROM THE SILICON THERMOMETER
            IF(IFUNC.NE.3)GO TO 820
C           FIRST SET UP THE HP 3495A TO THE PROPER CHANNEL
            M=IBUP(0,2,MPX2,3)
            IF(M.NE.0)GO TO 810
C      NEW READ THE DVM
            M1=IBUP(0,3,DVMON,4)
            M=IBUP(1,3,VALUE,15)
            M2=IBUP(2,3)
C      DECODE THE DVM DATA OUTPUT
            DECODE(13,100,VALUE) DVM
            GO TO 900
800    CONTINUE
C ERROR MESSAGE FOR ERROR IN INITIALIZATION OF HP 3455A
            WRITE(7,8000)
8000        FORMAT(' GPIB INITIALIZATION OF HP3455A FAILED')
            IF(ICOUNT.NE.0)STOP ' 3455A FAILURE'
            ICOUNT=1
            GO TO ERRET
810         CONTINUE
C ERROR IN PASSING COMMAND ARRAY TO MPX SCANNER.
            WRITE(7,8100)
8100        FORMAT(' GPIB FAILED TO SET HP3495 SCANNER PROPERLY')
            IF(ICOUNT.NE.0)STOP ' 3495A FAILURE'
            ICOUNT=1
            GO TO ERRET
820    CONTINUE
```

```
C FUNC HAS AN ILLEGAL VALUE
              WRITE(7,8200)
8200          FORMAT(' FUNC IN THE DVM ROUTINE HAS AN ILLEGAL VALUE')
900     CONTINUE
C RESET THE DVM TO READ TEMPERATURE VOLTAGE CONTINUOUSLY
        N=IBUP(0,2,MPX2,3)
        RETURN
        END
```

```
      INTEGER FUNCTION VLTAGE(VLTSET)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C THIS PROGRAM SETS THE HP39501A POWER SUPPLY PROGRAMMER TO THE
C THE DESIRED OUTPUT VOLTAGE.  THE POWER SUPPLY MUST BE SET TO THE
C UNIPOLAR MODE.  THE ALLOWABLE RANGE OF VALUES IS 0.00 TO 9.99 VOLTS.
C
C
C        AUTHOR:  CAPTAIN EDGAR A. VERCHOT, JR., USAF
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C DATA SPECIFICATIONS
      BYTE SETCOM(4)
C  FIRST ENCODE THE VOLTAGE SETTING TO THE PROPER VALUE IN ASCII CODE
      IVLT=(VLTSET*100)+2000
      ENCODE(4,100,SETCOM) IVLT
100   FORMAT(I4)
C NOW CALL THE HP39501
      I=IBUP(0,1,SETCOM,4)
      VLTAGE=1
      RETURN
      END
```

```
        .TITLE DMM      -- KEITHLEY DMM DRIVER
        .SBTTL --------- INTRODUCTION
;
;       PURPOSE: THESE ROUTINES SUPPORT THE KEITHLEY INSTRUMENTS, INC.
;                MODEL 616 DIGITAL ELECTROMETER EQUIPED WITH THE MODEL
;                6162 ISOLATED OUTPUT/CONTROL AS INTERFACED BY UDRI.
;
;       AUTHOR:  FRANK E. BEITEL (UDRI) 8-JUN-79
;
;*****************************************************************************
        .PAGE
        .SBTTL --------- INTERFACE DEFINITION
;
;
;*****************************************************************************
;
;
;       INTERFACE DEFINITION:
;
;           THE INTERFACE CONSISTS OF:
;
;               1. CABLE FROM DMM TO LOGIC BOX
;               2. CABLE FROM LOGIC BOX TO LSI-11
;               3. ONE DRV-11 INTERFACE BOARD TO PROVIDE 16 BITS OF DATA
;                  IN EACH DIRECTION
;               4. LOGIC BOX TO PERFORM DIGITAL SIGNAL CONDITIONING.
;
;*****************************************************************************
;
;       CONTROL SIGNALS FROM DMM TO COMPUTER
;       ------- ------- ---- --- -- --------
;
;       SIGNAL  CONN PIN        PIN     DESCRIPTION
;       ------  ---- ---        ---     -----------
;
;       REQA     J1  LL         10      FLAG (LATCHED IN LOGIC BOX)
;
;*****************************************************************************
        .PAGE
        .SBTTL --------- DEFINITIONS: DATA SIGNALS (DMM TO LSI-11)
;
;
;*****************************************************************************
;
;       DATA SIGNALS FROM DMM TO COMPUTER
;       ---- ------- ---- --- -- --------
;
;       SIGNAL  CONN PIN        PIN     DESCRIPTION
;       ------  ---- ---        ---     -----------
;
;       IN00     J2  TT         21      DISPLAY 1 X 10**3 (STROBE 8)
;       IN01     J2  LL         43      POLARITY
;       IN02     J2   H         13      ZERO CHECK
```

```
;       IN03    J2  BB          7     DP1 (DECIMAL POSITION)
;
;       IN00    J2  TT         30     DISPLAY 1 X 10**2 (STROBE 5)
;       IN01    J2  LL         25     DISPLAY 2 X 10**2
;       IN02    J2   H         26     DISPLAY 4 X 10**2
;       IN03    J2  BB         24     DISPLAY 8 X 10**2
;
;       IN00    J2  TT         47     DISPLAY 1 X 10**1 (STROBE 4)
;       IN01    J2  LL         29     DISPLAY 2 X 10**1
;       IN02    J2   H         28     DISPLAY 4 X 10**1
;       IN03    J2  BB         46     DISPLAY 8 X 10**1
;
;       IN00    J2  TT         17     DISPLAY 1 X 10**0 (STROBE 3)
;       IN01    J2  LL         12     DISPLAY 2 X 10**0
;       IN02    J2   H         11     DISPLAY 4 X 10**0
;       IN03    J2  BB         16     DISPLAY 8 X 10**0
;
;       IN00    J2  TT         42     EXP 1 X 10**1
;       IN01    J2  LL         41     EXP POLARITY
;       IN02    J2   H         44     F1                (STROBE 1)
;       IN03    J2  LBB        45     F2
;
;       IN00    J2  TT         37     EXP 1 X 10**0     (STROBE 2)
;       IN01    J2  LL         38     EXP 2 X 10**0
;       IN02    J2   H         35     EXP 4 X 10**0
;       IN03    J2  BB         34     EXP 8 X 10**0
;
;       IN00    J2  TT          8     DR (DOWN RANGE)   (STROBE 6)
;       IN01    J2  LL          9     UR (UP RANGE)
;       IN02    J2   H          -     ***UNASSIGNED***
;       IN03    J2  BB          -     ***UNASSIGNED***
;
;       IN00    J2  TT         22     DP2               (STROBE 9)
;       IN01    J2  LL          5     DP3
;       IN02    J2   H          6     DP4
;       IN03    J2  BB         23     DP5
;
;       IN00    J2  TT         31     MANUAL RANGE      (STROBE 5)
;       IN01    J2  LL         32     R1
;       IN02    J2   H         14     R2
;       IN03    J2  BB         33     R3
;
;*****************************************************************************
        .PAGE
        .SBTTL --------- DEFINITIONS: DATA SIGNALS (LSI-11 TO DMM)
;
;
;*****************************************************************************
;
;       DATA SIGNALS FROM COMPUTER TO DMM
;       ---- ------- ---- -------- -- ---
;
;       SIGNAL  CONN PIN        PIN   DESCRIPTION
```

```
;       -----   ---- ---         ---     ----------
;
;       OUT00   J1   C           36      STROBE 5
;       OUT01   J1   K            1      STROBE 4
;       OUT02   J1   NN          18      STROBE 3
;       OUT03   J1   U           19      STROBE 1
;       OUT04   J1   L           49      STROBE 2
;       OUT05   J1   N           48      STROBE 6
;       OUT06   J1   R           20      STROBE 8
;       OUT07   J1   T           39      STROBE 9
;
;       OUT08   J1   W            2      OUTPUT HOLD
;       OUT09   J1   X           50      DISPLAY HOLD
;       OUT10   J1   Z           31      MANUAL RANGE
;       OUT11   J1   AA          32      R1
;       OUT12   J1   BB          14      R2
;       OUT13   J1   FF          33      R3
;       OUT14   J1   HH          15      ZERO CHECK
;       OUT15   J1   JJ          --      STROBE S (LOGIC BOX CONTROL)
;
;*****************************************************************************
        .PAGE
        .SBTTL --------- DEFINITIONS: TRUTH TABLES
;
;
;*********************************  ***************************************
;                                 * *                                      *
;       FUNCTION       F2  F1     * *    SENSITIVITY     R4  R2  R1        *
;       --------       --  --     * *    -----------     --  --  --        *
;                                 * *                                      *
;       OHMS           0   0      * *       .01          0   0   0         *
;       COULOMBS       0   1      * *       .01          0   0   1         *
;       AMPERES        1   0      * *       .01          0   1   0         *
;       VOLTS          1   1      * *       .01          0   1   1         *
;                                 * *       .1           1   0   0         *
;                                 * *      1.            1   0   1         *
;                                 * *     10.            1   1   0         *
;                                 * *    100.            1   1   1         *
;                                 * *                                      *
;                                 * *                                      *
;*********************************  ***************************************
        .PAGE
        .SBTTL --------- DEFINITIONS: CONSTANTS AND GLOBAL SYMBOLS
;
        .MCALL  .REGDEF
        .REGDEF
;
; ***** DEFINE ENTRY POINTS
;
        .GLOBL  IDMMGT
;
; ***** DEFINE INTERRUPT VECTOR ADDRESSES
;
```

```
        .GLOBL  DMMRDY
        DMMRDY=330
;
; ***** DEFINE DEVICE ADDRESSES
;
;       .GLOBL  DMMCSR, DMMIN, DMMOUT
        DMMCSR=167750
        DMMIN=DMMCSR+4
        DMMOUT=DMMCSR+2
;
        .PAGE
        .SBTTL IDMMGT -- GET DATA FROM DMM
;
;       PURPOSE: FORTRAN CALLABLE FUNCTION WHICH CHECKS TO SEE IF THE
;                KEITHLEY DMM HAS DATA READY AND, IF SO, GETS IT.  THIS
;                FUNCTION RETURNS ZERO (.FALSE.) IF THE DMM IS DISABLED.
;
;       CALLING SEQUENCE:
;
;                L = IDMMGT (IDATA)
;
;          OUTPUT PARAMETERS:
;
;                L       -- TEST RESULT
;                           L = .FALSE. (OR INTEGER 0) -- NO DATA READY OR
;                                                         DMM DISABLED
;                               .TRUE.  (OR INTEGER 1) -- DATA READY
;
;                IDATA   -- 9-ELEMENT INTEGER VECTOR CONTAINING THE
;                           DATA READ FROM THE DMM.
;
;*****************************************************************************
;
IDMMGT:         CLR     R0                  ;R0,R1 <- FORTRAN LOGICAL .FALSE.
        CLR     R1
        BIT     #200,DMMCSR         ;IF DMM HAS DATA READY, THEN
        BEQ     2$
        MOV     2(R5),R2            ;   R2 <- ADDR(IDATA(1))
        MOV     #1,R3               ;   R3 <- MASK FOR STROBE
        MOV     #9.,R1              ;   R1 <- NUMBER OF CHANNELS TO STROBE
;
1$:     MOV     R3,DMMOUT           ;   FOR I = 1 TO 9.
        MOV     DMMIN,(R2)          ;      IDATA(I) <- VALUE FROM CHAN I
        BIC     #177760,(R2)+       ;      KEEP ONLY LOW ORDER 4 BITS
        ASL     R3
        SOB     R1,1$               ;   END FOR
;
        CLR     DMMOUT              ;   CLEAR DMM CONTROL REGISTER
        INC     R0                  ;   R0,R1 <- FORTRAN LOGICAL .TRUE.
;
2$:     RTS     PC                  ;RETURN

        .END
```

```
        .GLOBL  FLOAT
;
FLOAT:  CLR     R0
        MOV     &2(R5),-(SP)    ;GET THE INTEGER TO BE CONVERTED
        BGE     1$              ;IF NEGATIVE THEN
        MOV     #100000,R0      ;   R0 <- SIGN BIT ON
        NEG     (SP)            ;   MAKE IT POSITIVE
1$:     MOV     BIAS,-(SP)      ;MAKE IT FLOATING POINT
        CLR     -(SP)
        MOV     BIAS,-(SP)
        FSUB    SP
        BIS     R0,(SP)
        MOV     (SP)+,R0
        MOV     (SP)+,R1
        RTS     PC
BIAS:   .WORD   046000          ;THIS IS THE HIGH WORD OF A FLOATING POINT
                                ;2**24
;
        .END
```

```
        .TITLE IBCD
        .PSECT $CODE,RW,I,LCL,REL,CON
        .GLOBL IBCD
IBCD:           MOV     &2(R5),R1               ;GET FIRST ARG
        CLR     R0
        CLR     R3
        MOV     #4,R2
  1$:   ASHC    #4,R0                   ;SHIFT R0,R1 FOUR BITS
        MUL     #10.,R3
        ADD     R0,R3
        SOB     R2,1$
        MOV     R3,R0
        RTS     PC
        .END
```

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THE AHEEDAS SYSTEM IS AN OVERLAYED SYSTEM. IT WAS LINKED IN THE FOLLOWING MANNER. IF A LINK MAP IS DESIRED ASS LP: MAP:, OTHERWISE ASS NL: MAP:

```
R LINK
AHEDAS.SAV,MAP:=A0,HPDRIV,DX0:SYSLIB//
A1/O:1
A2,A3,A4,DRIVR2,FLOAT,DMMGT/O:1
IBUP1,IBVDP1,IBCD,MYLIB
A5/O:1//
```

THIS STRUCTURE SHOULD BE USED FOR ANY FUTURE VERSIONS OF AHEDAS IF THE OVERLAYS ARE TO WORK PROPERLY.

Vita

Edgar Alphonse Verchot, Jr. was born 15 January 1951 in Auburn, Alabama. He graduated from Decatur High School, Decatur, Alabama, in 1968. He then attended the University of Alabama in Tuscaloosa, Alabama, where he received the Bachelor of Science degree with a major in Physics in 1972. He continued study and received the Bachelor of Science in Electrical Engineering degree in 1974. He was commissioned at this time in the United States Air Force.

After graduation, he was employed by the Alabama Power Company in Tuscaloosa until he reported for active duty 15 August 1974. He was assigned as a Wing Flight Test Director with the 4950th Test Wing at Wright-Patterson Air Force Base until he reported to the School of Engineering, Air Force Institute of Technology in August 1978.

He is married to the former Deborah Jean Mobley and has one son, Edgar, III.

Permanent Address: 1302 Morningside Court, S. E.
Decatur, Alabama 35601

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER AFIT/GEO/EE/79D-5 ✓	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Automated Hall Effect Experiment Data Acquisition System(AHEEDAS)		5. TYPE OF REPORT & PERIOD COVERED M.S. Thesis 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Edgar A.Verchot, Jr. Captain USAF		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Air Force Institute of Technology(AFIT/EN) Wright-Patterson AFB, Ohio 45433		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Lasers and Materials Branch(AFML/LPO) Air Force Materials Laboratory Wright-Patterson AFB, Ohio 45433		12. REPORT DATE December 1979 13. NUMBER OF PAGES 205
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release, Distribution Unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Approved for Public Release; IAW AFR 190-17
Joseph P. Hipps, Major,USAF
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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Automation	LSI-11 Microcomputer	van der Pauw
Microcomputer	Hall Effect	silicon
Structured Analysis		
Automated Instrumentation		

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Air Force Materials Laboratory conducts experiments using the Hall effect to characterize the electrical properties and imputity levels of silicon samples. Both the van der Pauw and the classical Hall bar methods are used. The purpose of this study was the development of an Automated Hall Effect Experiment Data Acquisition System(AHEEDAS) to control the conduct of the experiment and to reduce all of the necessary data. The designed system is capable of controlling all aspects of the experiment except the temperature. over

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The AHEEDAS produces as output, sample resistivity, Hall mobility, carrier concentration, and the Hall coefficient as a function of temperature. These are stored in data files on floppy disk storage along with all of the raw data from the experiment. The output is also printed on the computer terminal as the experiment is done. An LSI-11 microcomputer with 28K words of memory is used to control the experiment. Software was developed to allow this system to handle the acquisition and processing of data. The AHEEDAS was successfully implemented and tested. All functions other than the temperature control are fully operational.